PROCEEDINGS OF
THE LINNEAN SOCIETY OF LONDON
Session 1952–53

Vol. 165 Part 2

PROCEEDINGS OF THE GENERAL MEETING HELD ON 5 February 1953

Lt.-Col. R. B. Seymour Sewell, C.I.E., F.R.S., President, in the Chair.

The Proceedings of the Meetings held on 8 and 29 January 1953, having been circulated, were taken as read, and confirmed.

The following were thanked for gifts made to the Library since the last Meeting :—Mrs. F. E. Weiss and the Highgate Literary and Scientific Institution.

The following signed the Obligation in the Roll and Charter Book, and were admitted Fellows :—Mr. William Henry Lomas, B.Sc., and Mr. David Norman Paton, M.A.

The President reported the deaths of Francis Rilstone, Associate *honoris causa*, and Prof. Geoffrey Douglas Hale Carpenter, M.B.E., and Lt.-Col. Leonard Charles Rudolph Messel, O.B.E., Fellows of the Society.

Read for the first time the following proposed Alterations in the Bye-Laws to facilitate consultation of the Society's Collections.

1. That Bye-Laws, Chapters 15, 16, 17, 18 and 19 be re-numbered 16, 17, 18, 19 and 20 respectively.

2. That there be a new Bye-Law, Chapter 15, worded as follows :—

Of the Collections of the Society.

Sect. 1. The Council shall appoint two Curators one Botanical and one Zoological who with the Secretaries shall be responsible to the Council for the care of the Society's Collections. Such appointments shall normally be for a period not exceeding three years but may be reviewed annually.

Sect. 2. No part of the Collections shall be removed from the Society's Apartments without leave of the Council except that a Curator or a Secretary may in person and at his absolute discretion remove from and return within fourteen days to the Apartments any specimens that it is desirable to examine and compare either in the British Museum (Natural History) or at the Royal Botanic Gardens, Kew. Every such removal and return shall be recorded in a book kept for this purpose and reported to the Council at their Meeting next ensuing.

Sect. 3. All preparations of whatever kind made from any specimen are the property of the Society. No investigator shall be permitted to retain any specimen or part of a specimen or any preparation for future use or reference.

Sect. 4. The Council shall make such orders as it may consider necessary for the proper execution of these Bye-Laws and for the better protection of the Society's Property.

3. That Chapter 12, Sect. 2, be re-worded to read as follows :—

   One of the Salaried Officers shall, under the authority of the Council, be responsible for the safe keeping of the property of the Society, whilst in the Society's Apartments, and shall give facilities to the Fellows and others duly authorized to consult the Library and Collections.

4. That the last sentence of the re-numbered Chapter 17, Sect. 6, reading, " No part of the Collections shall be removed from the Society's Apartments without leave of the Council ", be deleted.

The following communication was read and discussed :—

Dr. A. TINDELL HOPWOOD, Sec.L.S. Some primary aspects of classification. (Discussed by the President, Dr. C. F. A. Pantin, Prof. J. H. Woodger and Prof. D. A. Webb ; Dr. Hopwood replied.)

Abstract,—

Classification is a basic assumption underlying every branch of Science whether deductive or inductive, i.e. empirical. Each class is a universal formed by abstraction from its particulars and has no meaning apart from them. Consequently, in a ' finite abstractive hierarchy '—the phrase is Whitehead's—each class is not only a universal to its sub-classes and meaningless without them, but it is also one of the particulars to the next higher class and a factor in determining the meaning of that class.

Botanical and zoological classification is a special instance of the general principle.

The following papers were read in title :—

' On the name of the ground fluke *Fasciola terrestris* O. F. Müller, on *Othelosoma symondsi* Gray, and on the genus *Amblyplana* von Graff.' By C. F. A. PANTIN. [Published in *Journ., Zool.*, No. **285.**]

' A contribution to our knowledge of *Mallomonas*.' By KATHARINE HARRIS, B.Sc., University of Reading. (Communicated by Professor Tom Harris, F.R.S., F.L.S.) [Published in *Journ., Bot.*, No. **356.**]

' Studies in the Bangioideae. 2. The *Conchocelis*-phase of *Porphyra* sp. in *Pollicipes cornucopia* Leach at Roscoff.' By KATHLEEN M. DREW and K. SYLVIA RICHARDS. (Communicated by Professor H. Graham Cannon, F.R.S., F.L.S.) [Published in *Journ., Bot.*, No. **356.**]

' Some South African parasitic Florideae and their hosts. 1. Four members of the Rhodomelaceae which act as hosts for parasitic Florideae.' By M. A. POCOCK. [Published in *Journ., Bot.*, No. **356.**]

PROCEEDINGS OF THE GENERAL MEETING HELD ON 19 February 1953

Lt.-Col. R. B. SEYMOUR SEWELL, C.I.E., F.R.S., President in the Chair.

The Proceedings of the General Meeting held on 5 February 1953, having been circulated, were taken as read, and confirmed.

The following were thanked for gifts made to the Library since the last Meeting :—Mr. E. Couper Black, Mr. R. N. Lyne, Professor Nicholas Polunin, The Rev. H. Santapau, Colonel F. C. Stern, O.B.E., M.C., Major A. R. Tainsh, M.B.E., the Chief Librarian, Royal University, Uppsala and the National Oceanographic Council.

The following signed the Obligation in the Roll and Charter Book, and were admitted Fellows :—Mr. Francis Jessop Bingley, M.A., and Mr. J. Donald Grose.

The PRESIDENT reported the death of Professor James Herbert Orton, F.R.S., Fellow of the Society.

The following alterations in the Bye-Laws, incorporating Amendments by Council, were substituted for those recorded in the Minutes of the General Meeting, 5 February 1953, and were read for the first time :—

1. That Bye-Laws, Chapters 15, 16, 17, 18 and 19 be re-numbered 16, 17, 18, 19 and 20 respectively.

2. That there be a new Bye-Law, Chapter 15, worded as follows :—

OF THE COLLECTIONS OF THE SOCIETY.

Sect. 1. The Council shall appoint two Curators one Botanical and one Zoological who with the respective Secretaries shall be responsible to the Council for the care of the Society's Collections. Such appointments shall normally be for a period not exceeding three years but may be reviewed annually.

Sect. 2. No part of the Collections shall be removed from the Society's Apartments without leave of the Council except that a Curator or the Botanical or Zoological Secretary may in person and at his absolute discretion remove from and return within fourteen days to the Apartments any specimens that it is desirable to examine and compare with material either in the British Museum (Natural History) or at the Royal Botanic Gardens, Kew. Every such removal and return shall be recorded in a book kept for this purpose and reported to the Council at their Meeting next ensuing.

Sect. 3. No preparation of whatever kind shall be made from any specimen except with specific permission of a Curator or of the Botanical or Zoological Secretary and all such preparations are the property of the Society. No investigator shall be permitted to retain any specimen or part of a specimen or any preparation for future use or reference.

Sect. 4. The Council shall make such orders as it may consider necessary for the proper execution of these Bye-Laws and for the better protection of the Society's Property.

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4. That the last sentence of the re-numbered Chapter 17, Sect. 6, reading "No part of the Collections shall be removed from the Society's Apartments without leave of the Council", be deleted.

The following communication was read and discussed :—

Captain C. DIVER, C.B.E., Dr. V. M. CONWAY, Mr. J. G. SKELLAM and Dr. J. D. OVINGTON. On the Nature Conservancy. (Discussed by Dr. J. Ramsbottom, O.B.E., Mr. W. T. Stearn, Dr. A. Tindell Hopwood and Prof. C. T. Ingold ; Capt. Diver, Dr. Conway and Dr. Ovington replied.)

ON THE NATURE CONSERVANCY

NATURE RESERVES

By C. Diver.

The Nature Conservancy was constituted in 1949 and since then it has made progress in the conservation of suitable areas and in related programmes of research.

The most valuable areas, from the scientific viewpoint, are being declared as national nature reserves and are being protected by acquisition, by lease or by agreements with the owners on future management. This is often difficult since the land may also be in demand for forestry, agriculture, service training or some other development scheme, and it is then necessary to try to reconcile the conflicting interests.

Nevertheless, it has been possible to declare nine nature reserves in England and Scotland with a total area of about 22,000 acres and in addition negotiations for a further seventeen nature reserves are proceeding and informal arrangements have been made with the owners of other areas.

The scientific problems associated with the conservation of the natural fauna and flora are both complex and numerous, and two properties have been acquired, one in the Lake District and the other in Dorset for conversion into research stations where modern laboratories and equipment will be available for the main research programmes. Field investigations are however of the greatest importance, and field research stations are also being provided at the Moor House and Beinn Eighe reserves.

OTHER SITES OF SPECIAL SCIENTIFIC INTEREST

By V. M. Conway.

It is impossible for all scientifically interesting areas to be made into national nature reserves and under Section 23 of the National Parks and Access to the Countryside Act, 1949, the Nature Conservancy has to inform local planning authorities of areas within their boundaries which are of special scientific interest by virtue of their flora, fauna, geological or physical features. Fortunately, the local committees of the Nature Reserves Investigation Committee had made recommendations and these have now been checked and revised by the Nature Conservancy with the voluntary aid of many scientists and naturalists. In order to protect the various sites it is essential to notify them to the local authorities as soon as possible and it is hoped that the lists will be revised again in the next four or five years.

Once the sites are notified the local authorities are required to inform the Nature Conservancy of any proposed plans for development so that the Nature Conservancy can put forward the scientific case and attempt to reconcile different viewpoints.

But changes in agricultural or sylvicultural treatment, some of which may seriously affect scientific interests, are not development in this sense, and the Conservancy are not necessarily informed of such proposals.

QUADRAT SAMPLING FROM THE MATHEMATICAL STANDPOINT

By J. G. Skellam.

(With 11 text-figures.)

If an apology is still needed from those who attempt to introduce mathematical ways of thinking into Biology, I will try an escape by quoting Charles Darwin's celebrated remark: "I have no faith in anything short of actual measurement and the rule of three."

To-day the statistical analysis of observational data enters into all aspects of scientific work and it appears to do so in two main ways.

Firstly, mathematical functions may be used to describe numerical data in a concise manner, but owing to what might be called 'mathematical mimicry' there are usually several functions which may fit the same set of data tolerably well, at least over the range of values under consideration. The important advances only occur when mathematical descriptions of the numerical data can be found which can be given meaning in terms of a model or set of axioms from which the descriptive 'law' can be deduced rigorously as a logical and necessary consequence. The Laws of Mendel, for example, are essentially descriptions; the theory of the gene is the corresponding model.

In the field of Ecology there is no difficulty, happily, in formulating possible working models or idealized versions of the biological situation, and it is instructive to make such models as are suggested by observation and experiment and to deduce their consequences.

The difficulties which arise are mathematical, often of a most formidable nature, particularly if the initial set of hypotheses is at all involved. The art in this approach lies in knowing where and in what manner to make these simplifications without sacrificing reality too far.

In this way we not only discover functions which often turn out to be eminently suitable for fitting numerical data, but we also set up standards of comparison which act as a basis of reference against which the complexities of a real situation may be critically demonstrated.

In order to illustrate the mathematical (analytical) rather than the statistical (descriptive) approach, I propose to consider the question of quadrant sampling, a technique of obvious importance to those who must assess the floristic and faunistic changes which may be taking place in the same locality with the passage of time or to measure the differences which exist from place to place; and who must do so with known accuracy.

For a more rigorous treatment and further development of the subject, reference should be made to the mathematical literature (e.g. Skellam, 1952, *Biometrika*, **39**, 346–362). It is intended here to present the topic diagramatically and to appeal almost entirely to intuition.

For simplicity of treatment a restriction is imposed (except where otherwise stated) so as to admit only those organisms which consist of clearly defined individuals or distinct parts, each of which can be regarded as such. Each individual is then represented by a particle appropriately chosen (e.g. at the middle of the base of the shoot) in a manner analogous to that employed in elementary mechanics where a solid body is usually represented in a mathematical model by a mass concentrated in one particle, namely its centre of gravity.

As a preliminary model, consider a large number of particles scattered independently of one another and at random. A typical fragment drawn from such a model is shown in fig. 1. The density of the particles as estimated by a single quadrat would vary considerably from observer to observer. In order to illustrate the sort of variation that can occur from quadrat to quadrat,

a grid has been superimposed over the area. In fact, the probabilities with which 0, 1, 2, 3, . . . particles occur in a randomly chosen quadrat are those of the Poisson distribution, in this case (fig. 4) a Poisson distribution with mean equal to 1, because the squares are of such a size that only one particle is to be expected (on an average) per square. Poisson distributions for various means (3, 6, 9, . . .) are shown in fig. 6.

Sometimes a biologist's interest attaches not to the density of organisms but to the proportion of samples in which a given species occurs. For this, the term valence is now often employed instead of the somewhat unfortunate older term 'frequency'. This is not of course an absolute measure of anything in particular, and depends on quadrat size.

In the abstract model we are now considering there is in fact a simple mathematical relationship between the true proportion of occupied quadrats and the number of particles to be expected (on the average) per square. This relationship is shown in fig. 2.

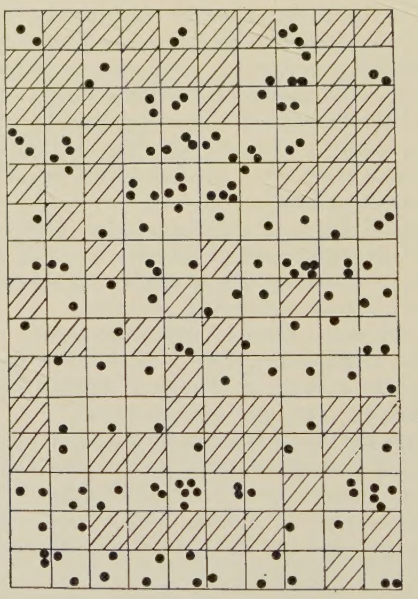

Fig. 1.

However, it is not advisable to utilize this relation to deduce the density from the valence, even if a sensitive quadrat size is employed (namely, one for which the valance is of the order of 70 to 85 per cent) except where the conditions of the model are strictly fulfilled. For if there were a tendency to aggregation such a procedure would underestimate the density. This conclusion is perhaps best seen by replacing each particle in fig. 1 by a compact cluster of two. The number of empty squares would remain the same, but the density would be doubled.

It is in general the practice among ecologists to calculate the valence of a species in a given region on the basis of only a few samples. The actual proportion of occurrences among the samples actually taken is used as an estimate of the true but unknown proportion. Fig. 3 is drawn to illustrate the magnitude of the sampling error involved, that is, it shows the whole population of estimates which would be obtained by repeating the calculation

over and over again with a fresh lot of samples each time. The true valence is taken as 0·7. If only 20 quadrats were used, the only possible answers must be multiples of 0·05 and these would be scattered about the true value with probabilities proportional to the lengths of the ordinates in the figure. If 100 quadrats were used, the possible answers would be sufficiently close

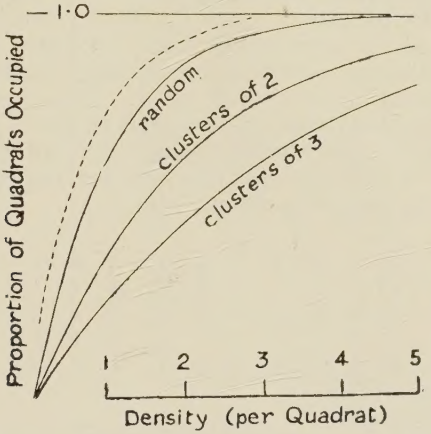

FIG. 2.

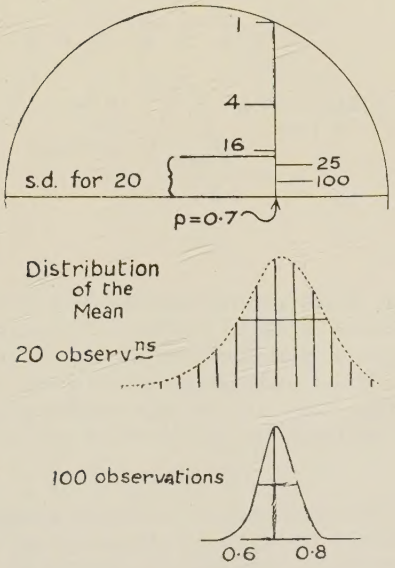

FIG. 3.

together to be looked on as 'continuous'. Even so, in about 5 per cent of cases, estimates would be obtained lying outside the range 0·6–0·8.

In these figures a horizontal line is drawn joining the steepest places on either side. This distance is in a sense a measure of scatter roughly equal to twice the standard deviation. A quick geometrical construction for obtaining the standard deviation for any given valence (p) and any stated number of

quadrats is shown in the upper part of the figure. The point to remember is that to effect a halving of the standard deviation, it is necessary to take four times as many observations.

It is worth while noting that the error involved in estimating the valence (for a given quadrat size) depends only on the proportion of squares which are empty and is not otherwise affected by the form or arrangement of the plants.

When we consider the estimation of the density this is not the case.

A set of 50 random values taken from a Poisson distribution ($\mu=1$) is shown in fig. 4. These are typical of the readings obtained by taking random quadrats in the model illustrated in fig. 1. The question is often asked: "How many such readings must be averaged to give a reliable picture of the true density?" In the case already illustrated, it will be seen from the lower figure that the use of even 100 quadrats will not infrequently give estimates which are in error by more than 20 per cent.

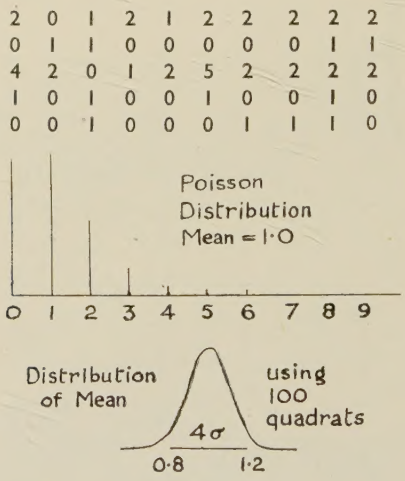

FIG. 4.

As often happens, such questions are wrongly framed, for with this kind of model (with randomly arranged particles) the important thing is not the number of quadrats *per se*, but the total number of particles expected in the total area sampled. If for example an investigator counts 10,000 particles, whether with a few large quadrats or a large number of small ones, the standard error of his estimate relatively to the true value will be approximately

$$1/\sqrt{(10{,}000)}=0{\cdot}01.$$

The second model for consideration consists of a number of compact clusters of particles. The clusters are scattered at random (as were the particles in the first model) and each cluster consists of a number of elements, varying independently from cluster to cluster. For simplicity of treatment it is here assumed that the number of elements (particles) per cluster is itself a Poisson variate, an assumption for which there is often very considerable justification, both practically and theoretically. Fig. 5 illustrates a fragment from such a model with superimposed grid. Each digit represents a cluster, and the numerical value of the digit indicates the number of elements in the cluster.

If we focus our attention on the total number of particles per square, we find that this number varies from square to square. Fig. 6 is intended to

illustrate in a particular case (in which the number of particles per cluster averages $m=3$) how the resulting distribution can be deduced. The first diagram shows how the number of clusters varies from square to square. If for example, there are two clusters, then the 'expected' (average) number of

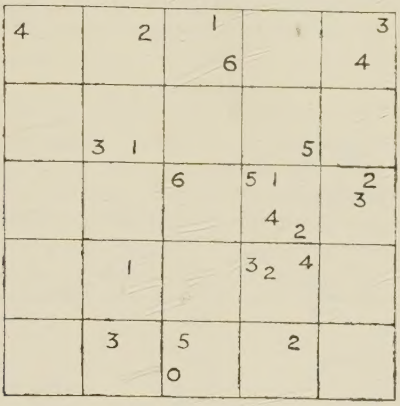

FIG. 5.

2 clusters per quadrat
3 plants per cluster
(on the average).

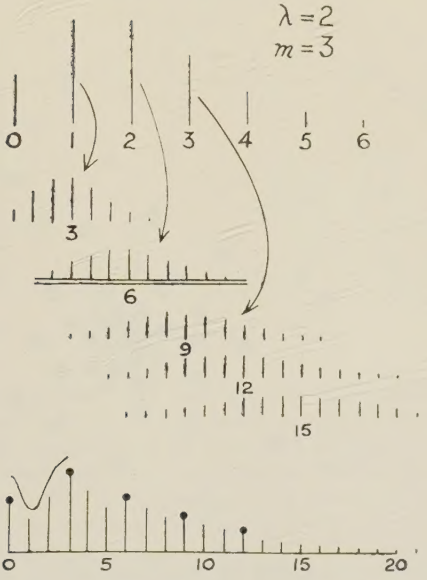

FIG. 6.

particles for the two clusters together will be six and the actual number of particles arising from two clusters will be distributed in the way shown underlined in fig. 6. By compounding all these possibilities in their right proportions we obtain what is known as a Neyman Type A contagious distribution.

In some cases there is a tendency for its terms to oscillate (as in the figure) and in particular a tendency to show a 'trough' to the right of the value 0.

When we sample from a contagious model we find that the number of particles varies from quadrat to quadrat often in a most alarming manner. In order to obtain an estimate of the density as accurate as one obtained for the simple random arrangement (first model), it is necessary to take $m+1$ times as many quadrats, where m denotes average cluster size.

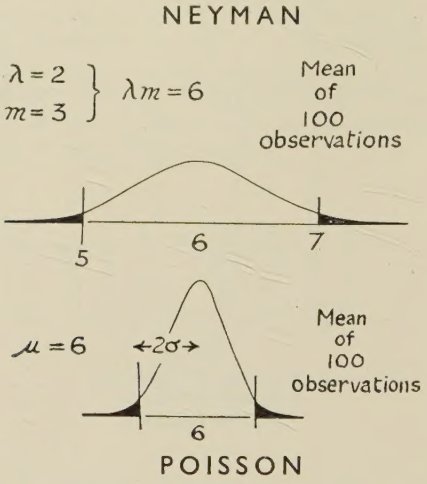

FIG. 7.

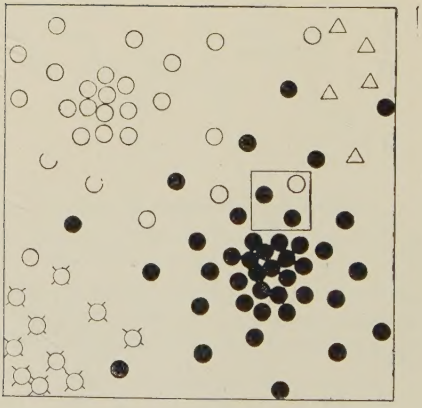

FIG. 8.

A comparison of the accuracy of estimates based on 100 quadrats for the two models is illustrated in fig. 7. Both have the same mean (6), that of the contagious distribution being due to there being an average of two clusters per quadrat, the numbers per cluster being distributed independently with mean = 3.

A third model (fig. 8) which has received attention consists of very loose, randomly arranged aggregates, the elements (particles) of which may even infiltrate between those of another. The arrangement of particles in each

aggregate may be likened to the arrangement of shots on a target, and in comparison with the spread of the aggregates, the quadrat size in this model is small.

Such an arrangement might apply for example to the case of certain larvae in the soil where loose aggregates have arisen by dispersion from batches of eggs arranged at random, that is, in a pattern which taken as a whole might be described as a random one, even though we may not be entirely unaware that in the ultimate analysis a variety of delicate considerations may be revealed which determine the choice of an oviposition site.

It has been found, by employing the mathematical function derived from this model, that in appropriate cases the frequencies with which 0, 1, 2, . . . individuals occur per quadrat agree so closely with the theoretical values that it is hardly possible to show them visibly in a diagram the size of fig. 10.

Since the spatial pattern of individual organisms is the outcome of processes operating in time, it is worth while to consider models of a more dynamic character. One such scheme is represented diagrammatically in fig. 9.

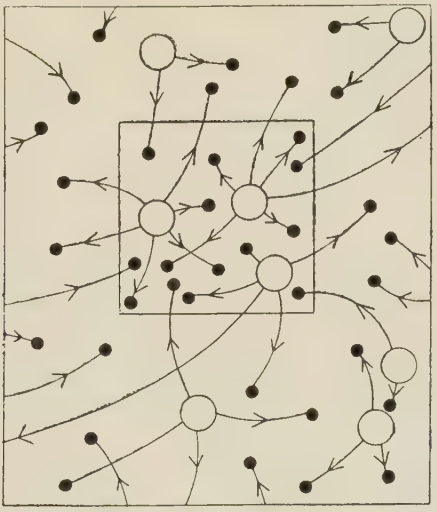

Fig. 9.

In this model the organisms are annuals and each produces numerous seeds. For mathematical simplicity it is assumed that all parents within the quadrat are equally *likely* to be represented by offspring within the quadrat in the next generation and that the number of organisms which are *likely* to arise from parents outside the quadrat is the same in all years. The actual numbers of offspring in each quadrat will however vary from quadrat to quadrat or year to year because of the operation of chance factors. Nevertheless it is still possible to speak of the state as one of dynamic equilibrium, and the mathematical problem consists in deducing the probability distribution of the number of individuals per quadrat.

The solution of this problem leads us to a distribution which was known to Pascal in the 17th century, the so-called negative binomial distribution. Fig. 10 shows such a function fitted to an actual set of frequency data. The agreement is almost 'too good' to have arisen by chance even if the model were strictly appropriate.

An interesting way of demonstrating how an arrangement of organism departs from a truly random one consists in showing how the distance r from an individual (A) to its nearest neighbour (B) varies from trial to trial. The purely random arrangement serves as a standard of comparison. In this case it can be shown that if the true density of particles is c/π then the quantity $z=cr^2$ has the familiar exponential distribution as shown in fig. 11 ($f(z)=e^{-z}$).

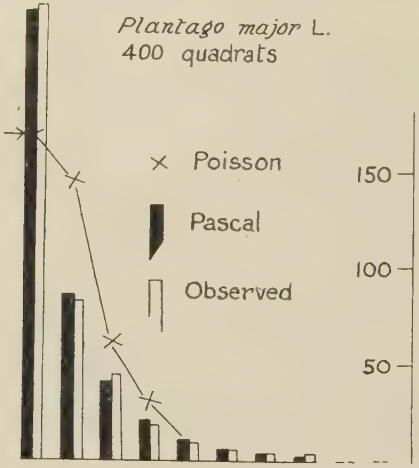

Fig. 10.

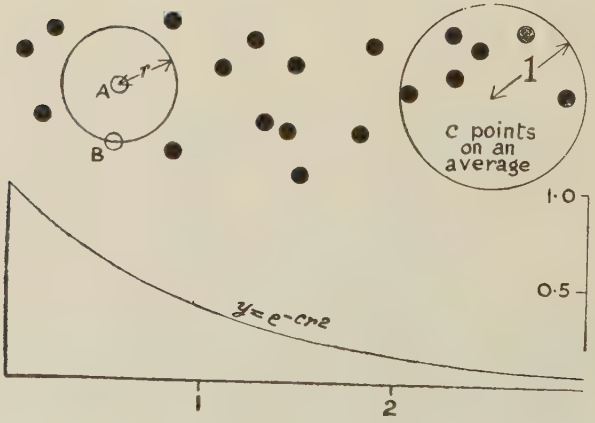

Fig. 11.

By this brief sketch I hope to have shown by the use of mathematical models how the accuracy of estimates of abundance by the quadrat method is affected by the spatial pattern of the individuals and to have indicated how appropriately formulated models may contribute standards of comparison to assist our understanding of spatial pattern.

THE ECOLOGICAL CONDITIONS OF DIFFERENT WOODLAND TYPES

By J. D. Ovington.

(With 1 text-figure.)

The extensive felling of the ancient forests of the British Isles with the greater industrial and agricultural demands of an increased population resulted in a serious depletion of timber resources until at the present time only about 5 per cent of the land is forest covered. Within recent times extensive re-afforestation programmes have been initiated and for economic and other reasons these new forests are frequently composed of pure stands of exotic trees planted in uniform even-aged blocks. The ecological conditions existing in these woodlands differ considerably from those found in more natural woodlands of native tree species. Since there is some evidence that secondary site factors may be modified by the type of forest established, the Nature Conservancy has initiated a programme of woodland research to compare the ecological conditions in different woodlands. The Forestry Commission and the owners of private estates have kindly co-operated in this investigation.

Several unique localities have been examined in detail; at each of these a number of woodland plots of different tree species had been established on a fairly uniform site. The plots are contiguous and straight sided so that they do not correspond to obvious site differences. After 20 years of afforestation marked differences in site conditions occur from plot to plot and these can be directly attributed to the type of tree species established. In all, 42 woodland plots at five different sites are being examined and these include 20 different tree species. Detailed reports are being published of the various aspects of this investigation and the present account is a general summary of its progress.

The forest crop differs from that of agriculture in that it may take almost a century to mature and during this time little, if any, soil cultivation takes place. Nevertheless the forester aims by careful sylvicultural management to keep annual increment as high as possible and in some cases the annual increase in weight of a tree crop is comparable to that of agricultural crops. The greatest standing crop weight recorded was that of a 21-year-old plot of *Abies grandis*, which despite heavy thinnings contained almost 700,000 kilograms of fresh material per hectare. In contrast an unthinned plot of *Quercus petraea* of the same age and at the same locality only contained 104,000 kilograms of fresh material per hectare. The weight of crop produced must therefore be considered in interpreting the effect of the trees upon the environment. Usually the weight of the standing crop increases to a maximum up to about the twentieth year, after which extensive thinning may result in a fall in crop weight. The tree canopies show a similar tendency but, in addition, as the trees become taller the living canopy is raised clear of ground level to leave an underlying zone of dead branches.

When a plantation reaches the pole stage the canopy forms an effective cover which modifies the micro-climate beneath it. Tree canopies vary considerably in type; spruces for instance have a greater frequency of lateral branching than oaks. Unlike the evergreen conifers, the broad-leaved hardwoods and larch are deciduous, so that these canopies exhibit marked seasonal changes. Even the canopies of the needle-leaved conifers differ greatly, the small needles of *Pseudotsuga taxifolia* giving a more complete cover than the longer needles of *Pinus nigra*. Measurements of light intensity and rainfall in the forest plots have reflected the diverse characteristics of the various tree canopies.

Tree canopies intercept the precipitation and in so doing diminish and redistribute unevenly the rainfall reaching the soil. In light showers as much as 93 per cent of the gross rainfall may be lost to the soil but in heavy showers

only 6 per cent or less is retained by the canopy. The penetration of the hardwood canopies by rain is much higher in winter than in summer. During light showers more moisture is retained on the coniferous canopies with their intricate mass of small needles than on the hardwood canopies. Although a few raindrops pass freely through the canopy the majority are intercepted and coalesce to fall as large drops on the forest floor. Detailed measurements of 2,000 raindrops in each of 13 forest plots have given characteristic distribution curves of raindrop size.

The herbaceous floras associated with the various woodlands differ considerably and this is hardly surprising in view of the diversity of the woodlands. The weight and floristic composition of the ground flora may be related to the age and closeness of the trees and to the type of woodland that has been established. In some deciduous plots such as that of *Fagus sylvatica* and in many of the plantations of young evergreen conifers the conditions are such that the ground flora is scanty or even absent. Fortunately records have been made by various scientists of the past floras in some of the older woodlands and it has been possible to reconstruct the development of the present floras. For instance, J. Macdonald records that the vegetation of a 23-year-old plot of *Pinus nigra* in the Forest of Dean was only scantily developed and consisted mainly of *Pteridium aquilinum* and *Galium hercynicum*. By the time this plot was 45 years old the ground flora gave an almost complete cover and consisted of four main herb species: *Rubus fruticosus, Pteridium aqulinum, Endymion nonscriptus* and *Holcus mollis*. The oven dry weight of this ground flora was almost 7,000 Kg. per hectare, about four times the weight of the ground flora in nearby oak plots of the same age. In 1929, when the flora of the pine plot was described as scanty, the floras of the oak plots were considered to be abundant.

Once established, the plantations begin to modify the soil-forming processes in various ways, so that the soils of the woodland plots are becoming increasingly dissimilar. The leaves of the tree stands are of different chemical composition and the rate and processes of decomposition of the surface litter vary considerbly. Under hardwoods such as oak, birch, ash or alder little surface organic matter accumulates but in the conifer plantations the decomposition of the litter is insufficient to keep pace with the annual litter fall, so that a surface organic layer builds up. The greatest recorded weight of surface litter (34,791 Kg. per Ha.O.D.) occurred in a 45-year-old plot of *Larix decidua* and the least (3,712 Kg. per Ha.O.D.) in a 46-year-old plot of *Quercus robur*. The litters differ considerably in type and may be classified by such factors as the different proportions of the litter and humus layers, the presence of a root mat and the degree of compaction. There is evidence that within broad limits the kind of tree species established is the primary factor in determining the type of litter formed. The nutrient content of the surface organic layer is relatively high, so that a well-formed surface organic mat represents a temporary removal of large quantities of nutrients from the active nutrient cycles.

The percentage volumes of mineral soil, water and air have been determined over a range of soil depths in the woodlands plots. Pore volume and aeration are much greater in the surface soils under the hardwoods than under most of the conifers, but where a luxuriant ground flora is developed this difference becomes less marked. The water content of the soil varies from plot to plot and this may be related to the amount of precipitation reaching the forest floor and to the uptake of water by the tree. A single tree of *Pseudotsuga taxifolia* 30 metres high was found to contain almost 700 Kg. of water in its bole and canopy.

Detailed chemical analysis of representative soil profiles has shown that as the trees mature the soils of the individual plots are being modified in

different ways. Afforestation results in a redistribution of such nutrients as phosphate, potassium, calcium and sodium in the soil profiles. These tend to be increased in the upper mineral soil and are particularly abundant in the surface humus, but this is only gained by a depletion of nutrients from the lowermost soil. The extent to which this redistribution develops is partially determined by the type of tree species established. The content of organic matter in forest soils is relatively high, but under stands of conifers the organic material is largely concentrated in the humus layers superimposed on the mineral soil. In contrast the hardwood litters tend to break down and be incorporated with the mineral soil; consequently the upper mineral soils of stands of *Alnus, Fraxinus, Quercus* or *Betula* contain a greater percentage of nitrogen and carbon than corresponding soils under conifer crops. The pH gradients down the soil profiles reflect these different chemical effects and in general the surface mineral soils of the conifer stands are becoming more acid than those of the hardwoods (fig. 1).

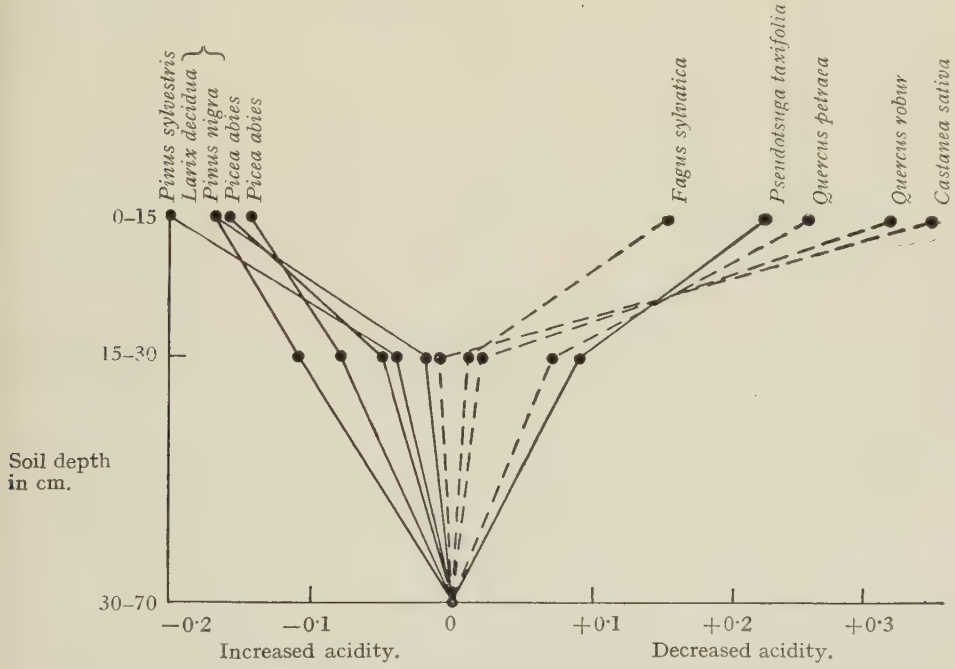

FIG. 1.—The change in pH of the soil after afforestation for 46 to 47 years. The plot of *Pseudotsuga taxifolia* is exceptional in that the stand is extremely open following extensive windblow.

The woodland community is extremely complex and by making a series of inter-related studies in the same plantations it is possible to obtain a more complete understanding of the association. It is hoped that the present research will be extended to include studies of the micro-flora and that comparable investigations will be made by the zoologists. Woodlands are however essentially dynamic communities and it is important to recognize not only the changing conditions as the trees mature but also the long-term effects of the trees in modifying site factors. The extent and nature of the change in site conditions are determined in part by the type of woodland established and their subsequent sylvicultural management. It is possible by careful selection of tree species and sylvicultural practice to conserve and possibly improve soil fertility.

PROCEEDINGS OF THE GENERAL MEETING HELD ON 5 March 1953

Lt.-Col. R. B. Seymour Sewell, C.I.E., F.R.S., President, in the Chair.

The Proceedings of the General Meeting held on 19 February 1953, having been circulated, were taken as read, and confirmed.

The following were thanked for gifts made to the Library since the last Meeting :—Mr. A. E. Blake, K.L.B., Mr. H. H. Bloomer, Professor R. Ruggles Gates, F.R.S., Mr. Charles McCann, Dr. R. E. Schultes, Mr. E. E. Sherff and the Hafner Publishing Co. Ltd.

The following signed the Obligation in the Roll and Charter Book, and were admitted Fellows :—Mr. David James Allott, B.Sc., Mr. Arthur Leslie Galliford and Dr. Arthur Hoyle Parkinson.

The President reported the death of Walter Mervyn Carne, Fellow of the Society.

The President read extracts from a letter from Mrs. F. E. Weiss thanking the Fellows for their Resolution of Sympathy on the death of Prof. Frederick Ernest Weiss, F.R.S., Fellow of the Society.

The proposed Alterations in the Bye-Laws to facilitate consultation of the Society's Collections were read for the second time.

Certificates of recommendation for election to Fellowship were read for the first time in favour of :—Prof. A. S. Boughey, Ph.D., John Francis Michael Cannon, B.Sc., Sydney Challenger, B.Sc., Roland Rhys Davies, B.Sc., Abraham Fahn, M.Sc., Ph.D., Peter Humphry Greenwood, B.Sc., Robert Desmond Meikle, B.A., LL.B., Plt. Off. Gerald Haig Mickleburgh, A.L.S., Walter William Pollard, B.Sc., A.L.S., George Henry Preston, Miss Alice Barbara Patricia Stevens, B.Sc., A.L.S., Peter Taylor, Leslie Gordon Glynn Warne, M.Sc., Ph.D., and Patrick Hazen Forbes White, M.A.

The following communications were read and discussed :—

Mr. A. S. Wright, F.L.S. A Ligulate Pteridophyte from the Lower Coal Measures of Bacup, Lancashire. (Discussed by the President, Mr. A. H. G. Alston and Dr. A. Tindell Hopwood ; Mr. Wright replied.)

Abstract,—

The specimen described is a main axis consisting of a central protostele with secondary thickening, separated by a wide gap from the secondary cortex. The chief peculiarity is the presence of curious appendages arising from the cortex. These appendages are very similar to Stigmarian rootlets but they bear ligulate leaves.

Mr. H. A. Hyde, F.L.S. A census of atmospheric pollen and its possible applications. (Discussed by Dr. E. M. Delf and Miss M. A. Todd ; Mr. Hyde replied.)

A CENSUS OF ATMOSPHERIC POLLEN AND ITS POSSIBLE APPLICATIONS

By H. A. Hyde.

(With 2 text-figures and 2 tables.)

Observations on the incidence or frequency of ocurrence of pollen in the air are likely to be of interest to various groups of workers: among others to students of floral biology, for obvious reasons; to plant breeders, for whom airborne pollen may be a complicating factor; to students of quaternary botany, for whom the analysis of the pollen accumulations of the recent past is of vital importance; and to the medical profession, which is concerned for the welfare of sufferers from pollen allergy. Some of these workers would prefer to have a measure of the amount of pollen contained in the air from time to time, expressed in grains per unit volume, others an index of the varying rate of deposition on the ground in the open expressed in grains per unit area. The method employed in the pollen census here described, viz. the so-called gravity slide method, yields data which probably give a fair indication of the changes in atmospheric concentration of the pollen concerned and also an approximation to the rate of deposition in the open. It has the great merit of being simple to instal and operate, and it gives results which appear to be sufficiently consistent to justify its continued use.

Briefly the method is as follows:—

An ordinary 3 × 1 inch microslide coated with glycerin jelly containing basic fuschsin as a stain is exposed continuously in a horizontal position and changed daily throughout the year. In order to protect it from rain the slide is placed centrally $4\frac{1}{2}$ in. beneath a disk 36 in. in diameter; a second disk is situated 11 in. below the first.

After being removed from the apparatus the slide is mounted with two $\frac{7}{8}$ in. coverslips and the entire area beneath one coverslip (5 sq. cm.) is scanned for pollen.

The census was begun by Dr. D. A. Williams and the writer in 1942 with one station, Llandough Hospital, situated in the country just outside Cardiff (Hyde & Williams, 1944). Since that year slides have been exposed by or for us at 12 other stations, usually for a year at each, sometimes more; the one in central Cardiff has been operated for over 10 years. We have determined some 90 per cent of all the grains on the slides we have counted as belonging to one or another of 65 types. About one-half of these have been determined generically, the other half by families. The principal pollen types we have recognized are listed in Table I in order of their numerical importance.

It is convenient to group the catch under the three headings, trees, grasses and (other) herbs, as in fig. 1, in which the influence of the vegetational background is clearly apparent. Thus, tree pollen is very prominent at Cardiff, Cambridge and Paddington, three stations around or near which park trees are very numerous; elsewhere trees are less numerous or completely absent, and the tree pollen catch is much smaller. The catches of particular types vary according to whether local sources are numerous or few. In general the farther source plants are away from the apparatus upwind, and the fewer they are, the smaller is the catch. A daily catch of 50 grains or more of a particular

type on 5 sq. cm. can usually but not always be related to a source within less than $\frac{1}{4}$ mile (Hyde, 1950).

The aggregate pollen catch at Cardiff has varied from year to year: in 1947 it was only half what it had been in 1946. All individual types have varied, some more than others, and these variations must in general be ascribed to variations in the amounts of pollen actually formed and liberated from year to year; while these in their turn appear in some instances to be related to weather experienced during the formative period, i.e. at the time when the flowers or the flowering shoots were being laid down (Hyde, 1952). Thus in trees it is generally supposed that flower formation is favoured by

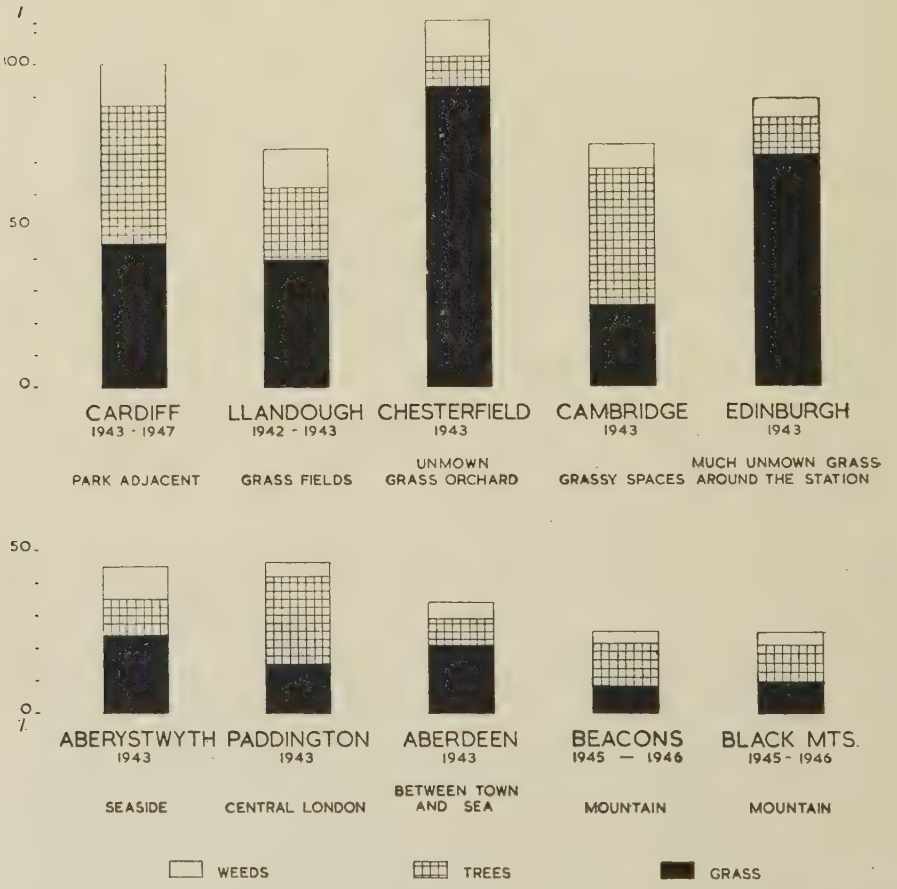

Fig. 1.—Atmospheric pollen at 10 stations in Great Britain. The standard of comparison is the average annual catch at Cardiff (roof of the National Museum of Wales) during the years 1943 to 1947 (inclusive), viz. 24,300 grains (approx.) on 5 sq. cm. For further explanation see text.

warm dry weather at the relevant period. The amount of pollen liberated by spring flowering trees might therefore be expected to vary from year to year according to the weather of the preceding summer. In Table II the years 1943–51 (inclusive) are set out (column 2) in inverse order of summer rainfall (June–September); the order obtained (column 3) by evaluating rainfall, sunshine and temperature jointly (using arbitrary scales for the purpose)

differs in the position of one year only. On the whole the warmest, driest and sunniest summer during the nine-year period 1943–51 was 1949, which would lead us to expect that on the whole spring flowering trees as a group would produce most flowers and shed most pollen in 1950. The coolest, wettest and dullest summer was in 1946, and 1947 might be expected to yield on the

TABLE I.—Principal types of pollen caught from the air at Cardiff (1943–52) and 12 other stations (1–3 years between 1942 and 1952): percentages of aggregate (all grains determined=100 per cent).

	Pollen type	Per cent		Pollen type	Per cent
1	Gramineae (Grasses)	48·3	16	Compositae (entomophilous)	0·56
2	*Ulmus* (Elm)	11·6	17	*Sambucus* (Elder)	0·48
3	*Quercus* (Oak)	8·2	18	*Salix* (Willow)	0·48
4	*Plantago* (Plantain)	4·2	19	*Populus* (Poplar)	0·46
5	*Urtica* (Nettle)	4·0	20	Juncaceae (Rushes)	0·43
6	*Fraxinus* (Ash)	3·8	21	Chenopodiaceae	0·42
7	*Betula* (Birch)	2·7	22	*Ranunculus* (Buttercup)	0·41
8	*Rumex* (Sorrel & Dock)	2·2	23	*Castanea* (Sweet Chestnut)	0·40
9	*Pinus* (Pine)	1·5	24	Ericaceae	0·38
10	*Alnus* (Alder)	1·2	25	*Artemisia* (Mugwort)	0·31
11	*Corylus* (Hazel)	1·0	26	*Acer* (Maple & Sycamore)	0·25
12	*Platanus* (Plane)	0·9	27	Umbelliferae	0·24
13	*Fagus* (Beech)	0·85	28	*Aesculus* (Horse Chestnut)	0·23
14	*Taxus* (Yew)	0·84	29	Cyperaceae (Sedges)	0·22
15	*Tilia* (Lime)	0·66	30	*Carpinus* (Hornbeam)	0·16

NOTE: *Ulmus* stands much higher than it would but for the many elm trees in central Cardiff.

TABLE II.—Pollen production in spring flowering trees and preceding year's summer weather (June–September). Cardiff 1943–51.

Expected order based on summer weather (June–September) of preceding year			Actual order (15 types jointly)		No. of types at their maximum	No. of types at their minimum
	Rainfall alone	Rain, sun and temperature jointly				
1	1950	1950	1	1950	7	
2	1948	1948	2	1948	3	1
3	1943)	1943	3	1946	1 (oak)	
4	1946)	1946	4	1943	2 (incl. ash)	
5	1944)	1944	5	1944		
6	1945)	1945	6	1949	1	1
7	1949	1951	7	1945		1
8	1947	1949	8	1951	1 (birch)	4
9	1951	1947	9	1947		8

NOTE: In column 2 the brackets indicate that the years concerned had the same rainfall.

whole the poorest crops of tree pollen or, if rainfall only were to be considered, 1951. Expectation during the other years would be in the order shown. The actual (joint) performance of 15 types has been calculated by totalling their respective percentage of average year by year, and it is seen that on the whole the most productive year for spring flowering tree pollens was in fact 1950 and

the least productive was 1947; and the other years fell, if not in order of expectation, at least not far from it. During these nine years dry summery weather was on the whole conducive to flower formation in spring flowering trees, but all kinds of spring flowering trees did not respond to the same degree: the highest catch of oak pollen came not in 1950 but in 1946, of ash in 1943, and of birch in 1951. It would appear therefore that some factor or factors must be at work other than weather at the formative period.

Pollen trapping on daily slides enables us to record not only the first appearances of our various types but also the entire period during which they are present in the air. The day to day frequency diagrams for certain types, including *Fraxinus*, *Quercus*, *Betula*, *Pinus* and some other trees, and among herbs by *Artemisia*, all present a similar 'compact' pattern: the catches are confined to a well-defined period and are grouped more or less symmetrically about a central peak date (Hyde, 1950). Such diagrams appear to reflect both the flowering period of the species concerned and also to integrate its intensity. Unfortunately only a limited number of pollen types in this country represent single species but the phenology of those species at any rate might be determined more completely by pollen trapping over a period of years than would be practicable by purely visual estimation of their flowering. Another group of pollen types including, e.g., *Alnus*, *Plantago* and *Urtica*, give 'diffuse' frequency diagrams, in which the shallow rises and falls appear to be produced by successive waves of flowering in local populations and indicate no general peak date.

Various kinds of pollen derived from entomophilous plants have been caught regularly at our stations: they form 4·75 per cent of all grains determined. The 20 principal types concerned, with the number of stations (other than Cardiff) at which they have been caught and their average frequency, are as follows:—*Tilia* (10 out-stations, 64 grains out of every 10,000 determined), *Compositae* (excluding *Artemisia*) (12, 63), *Sambucus* (12, 48), *Salix* (11, 44), *Ranunculus* (12, 42), *Castanea* (8, 40), *Calluna* (12, 30), *Acer* (12, 27), *Umbelliferae* (12, 25), *Aesculus* (9, 24), *Rosaceae* (arboreal) (12, 20), *Cruciferae* (12, 17), *Ligustrum* (9, 8), *Leguminosae* (11, 5), 'Spiraea' (probably *Ulmaria palustris*) (6, 4), *Hedera* (4, 2), *Galium* (12, 2), *Thalictrum* (8, 1), *Ilex* (7, 1) and *Caryophyllaceae* (7, 1). All these have been caught at Cardiff; the majority, including all the commoner ones, regularly ever year. *Calluna* has been caught at every station, notwithstanding that source plants are absent from the neighbourhood of several stations; *Calluna* flowers are known to pass first through an entomophilous phase and then through an anemophilous one. The figures stated appear to show that imperfectly entomophilous flowers may be commoner than has been supposed.

The variations (referred to above) in the annual output of the various kinds of tree pollen are not purely local: pollen counts made on slides exposed in the Brecknockshire mountains, 33 miles from Cardiff, show variations from year to year corresponding to those at Cardiff. A preliminary attempt has been made to correlate these variations with those in the seed crops obtained from forest trees (Hyde, 1951). The results, so far as they relate to ash and beech, are set out in fig. 2. Good seed crops of ash were obtained as far away as Denmark in 1943, 1946, and 1949, the three years when ash pollen was at its highest at Cardiff (Larsen, 1950). If the close relation between pollen output and seed crop, which some of our figures suggest, could be substantiated, foresters would have at hand a method of predicting probable seed crops. A similar opinion based on observations on flowering and seeding in birch has recently been expressed by Sarvas (1952).

If the present is the key to the past then analyses of present-day deposits of pollen considered in relation to existing vegetation ought to have some bearing

on the interpretation of pollen analyses from deposits of an earlier time. The highest and most characteristic type of vegetation at a particular period is its woodland, and pollen statistical work has naturally centred on tree pollen. There has been considerable debate on the interpretation of analyses of fossil tree pollen from peat bogs and lake muds in terms of contemporary woodland composition. Pohl (1937) worked out, for a range of forest trees, their average pollen productivity per hectare of a close stand of each over a period of years, and hence showed how the percentage composition of pollen deposited from the atmosphere should be corrected to give that of the woodlands concerned. His pollen figures were in part based on conjectural assumptions relating to the frequency of occurrence of ' bumper ' years. We can now replace these

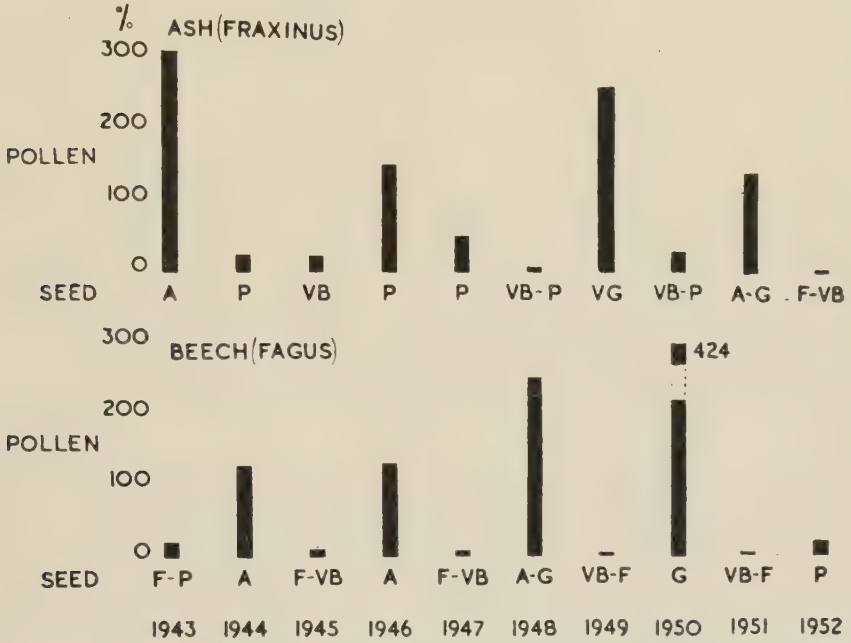

FIG. 2.—Pollen catches at Cardiff and seed crops in England and Wales compared. The pollen catches are expressed as percentages of the ten-year average. Verbal estimates of seed cropping are abbreviated thus : VG very good, G good, A average, P poor, VB very bad, F failure. Estimates for ash due to the Forestry Commission and down to 1947 relate to South Wales only ; those for beech due in part to Dr. E. W. Jones.

assumptions by actual observations of the variation in pollen output, and can revise Pohl's conclusions. Thus if the pollen analysis of a peat sample gives oak/birch as 50 : 50, the forest composition as calculated by using Pohl's factors would be 90 : 10, but as corrected by us would be 71 : 29. It would seem that, in pollen analyses of peat, birch at any rate is not so highly over-represented by its pollen as Pohl's factors suggested.

It has been known since 1873 that hay-fever (accompanied often by asthma) is produced in susceptible persons by inhaling pollens, and some 15 of the types listed in Table I have been shown to be antigenic. No kind of pollen is likely to evoke symptoms in a significant number of people unless it is formed and liberated in large quantities and is buoyant (so becoming and remaining airborne) and unless the source plant is widely and abundantly distributed.

The results of the Cardiff pollen census, when considered in the light of this principle, show that the chief hay-fever plants of Great Britain are relatively few in number, viz. the grasses considered as a single group (since all kinds of grass pollen are generally assumed to be similarly antigenic), certain trees, viz. the oaks, ash, the elms and plane (notably in London), and certain herbs, viz. the plantains, docks and sorrels, and possibly common nettle. It is necessary before forming a diagnosis on a particular patient's hay-fever to be able to show that his symptoms coincided with or at least fell within the period during which he was actually inhaling the pollen concerned. For this purpose reference to the frequency diagrams is essential. The grass pollen season recurs between dates which vary little from year to year and in the lowlands (apart from the largest towns) exposure to grass pollen during this period is inevitable (Hyde, 1952); but other kinds of pollen vary so much either in their periods of occurrence or in their intensity, or both, that the only satisfactory method of determining the vital dates for a particular place and year is by pollen trapping.

References.

Hyde, H. A. & Williams, D. A. 1944. Studies in Atmospheric Pollen I. A daily census of pollens at Cardiff, 1942. *New Phytol.*, **43**, 49–61.

Hyde, H. A. 1950. Studies in Atmospheric Pollen IV. Pollen deposition in Great Britain, 1943. Part 1. The influence of situation and weather. *New Phytol.*, **49**, 398–406.

——. 1952 a. Studies in Atmospheric Pollen V. A daily census of pollens at Cardiff for the six years 1943–8. *New Phytol.*, **51**, 281–293.

——. 1952 b. Grass pollen in Great Britain. *Acta Allergologica*, **5**, 98–112.

Larsen, C. Syrach. 1950. Private communication.

Pohl, F. 1937. Pollenerzeugung der Windblütler. *Beit. Bot. Centr.* A.**56**, 365–470.

Sarvas, R. 1952. On the flowering of birch and the quality of seed crop. *Comm. Inst. Forest. Fenn.*, **40.7**, 3–38.

PROCEEDINGS OF THE GENERAL MEETING HELD ON 19 March 1953

Lt.-Col. R. B. Seymour Sewell, C.I.E., F.R.S., President, in the Chair.

The Proceedings of the General Meeting held on 5 March 1953, having been circulated, were taken as read, and confirmed.

The following were thanked for gifts made to the Library since the last Meeting :—Mr. I. H. Burkill, Mr. H. E. Goto and Mr. Richard Morse.

The President reported the deaths of Dr. François Gagnepain, Foreign Member, and John Walker Walton and Atulananda Das, Fellows.

The President announced that the Council had nominated Professor P. A. Buxton, C.M.G., F.R.S., for the award of the Linnean Medal for 1953.

The proposed Alterations in the Bye-Laws, as printed in the report of the Meeting held on 19 February 1953, were balloted for and accepted.

Certificates of recommendation for election to Fellowship in favour of those candidates whose names are printed in the report of the Meeting held on 5 March 1953 were read for the second time, and for the first time in favour of Alan Sydney Fuller, B.Sc. and Dr. James Harry Smith, O.B.E., J.P.

Certificates of recommendation for election to ordinary Associateship were read for the first time in favour of :—John Alan Barker, Miss Kathleen Isabel Margaret Chesters, B.Sc., and John Griffith, B.Sc.

The following communication was read and discussed :—

Mr. Frank L. Hill. The Natural History of the Monte Bello Islands. (Discussed by the President, Mr. I. H. Burkill, Miss N. Burbidge, Mr. N. D. Riley, Dr. H. W. Parker, Dr. J. Ramsbottom, Miss P. Lewis, Dr. A. Tindell Hopwood and Mr. N. Y. Sandwich ; Mr. Hill replied.)

NOTES ON THE NATURAL HISTORY OF THE MONTE BELLO ISLANDS

By Frank L. Hill.

(Plate 1 and 1 text-figure.)

It should be made clear that the author is neither botanist nor zoologist, but was sent to the Monte Bello Islands for a purpose quite unconnected with Natural History. Collecting was a side-line and could be carried out only as a spare-time occupation. A much better job could have been done by a full-time qualified collector, but one could not be included because the nature of the expedition, which was in connection with the testing of the first British Atomic Weapon, imposed special limitations on the size of the party.

The Monte Bello Islands comprise a group of some two hundred islands situated about 50 miles from the coast of N.W. Australia. They vary in size from rocky platforms a few yards across to the larger islands some miles in extent. (See map, fig. 1.)

The two largest islands are Hermite and Trimouille, and these present a considerable contrast in appearance and vegetation. Hermite is the larger, being about 2 miles wide by 6 miles long, but the coast-line is so indented that no part of the island is more than half a mile from the sea. Some parts, especially the hill tops, are rocky, and other parts consist of flat dried mud like the bed of a dried-up lake.

Trimouille is much less indented in outline and has large stretches of almost bare sand. The islands are not coral islands but are formed of limestone similar to that of the adjoining mainland. What appears to be sand is in fact powdered limestone, 90 per cent soluble in dilute acid but having the appearance and texture of sand. This sand is blown into dunes with typical dune vegetation of tough grasses and xerophytic plants.

Most of the islands are bounded by low cliffs some 6 to 10 feet in height, undercut and with a flat shelf at the base, covered at high tide. These low cliffs give the shores a very sharply-defined outline and when seen from the air the islands, with their fantastic shapes and sharp vertical edges, look like pieces of a gigantic jig-saw puzzle resting on the ocean. At some points the cliffs give way to sandy beaches and in a few places rise to about 80 feet. The rock faces are eroded by salt spray and wind-blown sand into a sort of tufa rock. Typical rocky and sandy localities are shown in Pl. 1, figs. 1 and 2.

The climate is very pleasant with temperatures generally around 80° F. and with cloudless skies. The chief variable element is wind. Sometimes it is still, more often there is a stiff breeze and occasionally, especially in the rainy season which generally lasts only a few days in the summer, winds up to hurricane force may occur. These strong winds limit the height of the trees, anything exceeding a height of 3 to 4 feet being blown out of the ground.

Hence in open places the tallest plants are shrubs of 3 to 4 feet, a typical example being *Acacia coriacea*. The only places where real trees grow are in the mangrove swamps which occur in sheltered landlocked bays.

There is no fresh surface water on the islands and during the dry season all organisms have to rely on the heavy dew which occurs at night.

Fig. 1.

The islands have been visited from time to time. In the early part of the present century T. H. Haynes spent some time there experimenting with the culture of pearls and he sent some zoological specimens to the British Museum. They proved to be of considerable interest and in 1912 P. D. Montague and L. Burns organized an expedition to the Islands to collect zoological material. They spent three months, June to August, in the locality and a report of their work appears in *Proc. Zool. Soc. Lond.* September 1914. Since this time fishermen and pearlers have visited the islands from time to time, but no permanent settlement has been made.

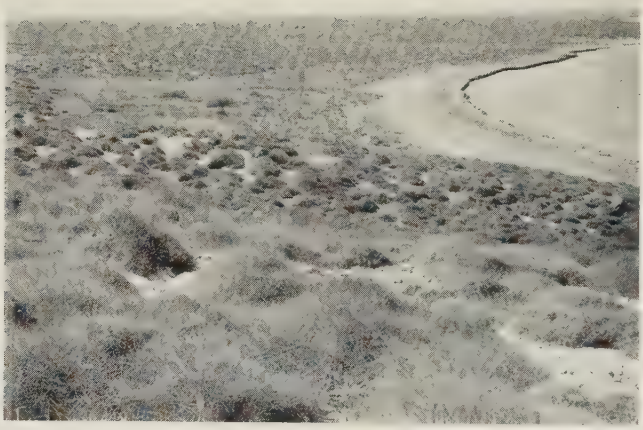

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FIG. 1.—Rocky Locality (Hermite).

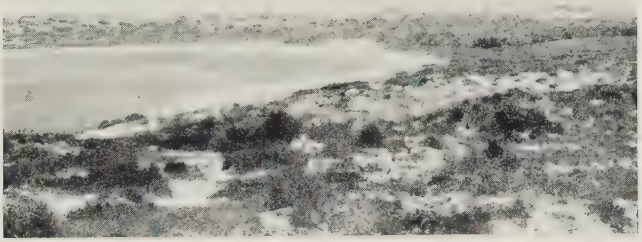

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FIG. 2.—Sandy Locality (Trimouille).

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FIG. 3.—Mangrove Swamp.

Our expedition arrived early in August 1952 and left towards the end of October, and so we could expect to find some insects different from those in Montague's collection, but whereas he was there after a two-years' drought we were fortunate in having some quite heavy out-of-season rain-fall a few weeks before our arrival, and so the vegetation was in better condition than usual. There appears to have been no previous botanical collection from the islands.

Among the animal population marine mammals were plentiful, including whales, dolphins and porpoises, but there was little chance of observation at close quarters except in the case of a bottle-nosed whale which was stranded on one of the beaches. Unfortunately time did not permit a dissection and it had to be left to the flies which later became a nuisance to people working in the area.

Montague lists two terrestrial mammals, a hare wallaby, *Lagorchestes conspicillatus* and a bandicoot, *Isoodon barrowensis*. No trace was found of either of these and it appears that, as Montague predicted, these have been exterminated by the cats introduced from a wreck. Another introduced mammal is the black rat, *Rattus rattus*, which is still present in large numbers on Trimouille and South East Island, but appears to be absent from Hermite, whereas the cats are confined to Hermite. These facts may not be unconnected.

The only other mammal is a bat, *Eptesicus pumilus*, a single specimen of which flew into one of the ships. They appear to be scarce, as no others were seen flying either ashore or round the ships.

The bird collection was disappointing. Before leaving this country the author was instructed in bird skinning at the British Museum, but it was soon found that getting a reasonable bird collection was a whole-time job, and since no one could be found to undertake it, it had very reluctantly to be abandoned. A few specimens were taken, including a sacred kingfisher, *Halcyon sancta*, a barred-shouldered dove, *Geopelia humeralis*, and a honey-eater, *Stigmatops indisincta perplexa* and the Monte Bello pipit, *Anthus australis montebelli*, all described by Montague, and a kestrel, *Falco cenchroides*, not on Montague's list. There were many other birds of prey, including a sea-eagle *Halliaetus leucogaster* and an osprey, *Pandion halliaetus melvillensis*. The ospreys built nests on many of the islands, making a very large nest up to five feet high and as much across. Pelicans were seen from time to time and one has to see these birds in flight to realize that they are not always ungainly and ugly.

Reptiles are fairly numerous, especially lizards, which occur in all sizes from three inches to four feet. The largest is Gould's Monitor, *Varanus gouldi*, which is fairly common on Trimouille, South East, Alpha, and North West Islands, but appears to be absent from Hermite. It seems to prefer wide sandy beaches and these are of less frequent occurrence on Hermite. It will take to the water and swim if pursued. Two other interesting species are *Lygosoma bipes* with hind legs but no fore legs and *Physignathus gilberti* which stands up and runs on its hind legs when in a hurry. The *Lygosoma* used to come into the tents at night and there would be a frantic effort to catch it before it got away. Also included in the collection is a new species of *Aprasia*, a minute burrowing legless lizard and a snake, *Pseudelaps christeanus*, which is new to the British Museum collection.

Some fish were collected, but these appear to be mostly widely distributed types. Sharks and rays were plentiful and even where bays were wired off the venomous stone fish was liable to occur, and so very little swimming was indulged in. A fish which was thought to be a stone fish was collected, but it turned out to be a false stone fish, *Halophryne diemensis*.

Among insects one of the most interesting groups is the Hemiptera. Out of ten species collected five are completely new and of the remaining five,

one is new to the British Museum. Five species of marine skaters are included, one species of *Hermatobates* and one *Halovelia* being new, the other new species being a *Cephaloplatus*, a *Siphanta* and a *Tartessus*. A single specimen of a Scarabaeid beetle cannot be referred to any hitherto recognized genus; it is new to science and provides a link between two hitherto very distinct tribes of the Melolonthoninae.

For moths and other night-flying insects a mercury-vapour lamp moth trap was used. This could be used only sparingly as so many specimens were taken that it was several days before they could all be dealt with and then some would be too dry for papering. One moth was bred from the larva, all stages to imago being preserved, together with the food plant, which was later identified as a species of *Phyllanthus*.

Among Hymenoptera there was a large and fierce-looking wasp to which everyone gave a wide berth and so we did not find out if it was as formidable as it looked.

Diptera were numerous and varied and at one time the author's tent was lined with pickle jars in which the breeding out of gall flies was being carried out. These insects, which are of a hitherto unknown species, form galls on a small shrubby plant, *Corchorus walcottii*. Again, all stages, larva, pupa and imago, were preserved.

Isoptera were represented by the termite, *Nasutitermes triodiae*, whose nests are found all over Hermite and a few on Alpha Island, but none were seen on Trimouille.

Crustacea included shrimps, mantis shrimps, and crabs. The mangrove swamps formed a home for many types, including a scarlet burrowing crab. This disappeared into a burrow as soon as one approached within twenty feet. The only way a specimen could be obtained was by taking a pot at it with the shot gun.

Passing now to the vegetation, this will be dealt with according to habitat, namely (1) crevices in rocks, (2) sandy beaches, (3) sand dunes, (4) inland areas, and (5) mangrove swamps.

Typical plants of rocky regions are *Breweria media* with greyish-green foliage and pale mauve flowers about an inch across. This is to be found on Alpha Island and is scarce on Trimouille. Many species of *Euphorbia* and the allied genus *Phyllanthus* are to be found growing in the rock crevices and in the southern part of Hermite there is a *Nicotiana* species which flowers in profusion so as to scent the evening air.

Two species of Capparidaceae are to be found in the rocks, the very widely distributed *Polanisia viscosa* and *Capparis nummularia*. The *Capparis* provided an interesting problem. It was seen soon after our arrival as a neat, round bush with orbicular leaves, but no flowers or fruits. It was observed in many places later but always without any means of identification, except that in one case the partially decomposed remains of a fruit, like an orange star-fish, was found. South East Island, a small rocky island off the southern tip of Trimouille, had not appeared to offer much to the collector. A visit was, however, paid to South East, and this was amply rewarded. Several species not found elsewhere in the group were collected, and the *Capparis* was found with flower-buds and faded flowers, but no fresh blooms. The buds partially expanded in water, but it was not until a few days before the expedition was due to leave that the plant was seen in full flower and this was a fine sight. The flowers are creamy white, two and a half inches across, the centre a mass of stamens, and emitting a very strong and sweet fragrance. The plant is a night-flowering species, the flowers fading quite early in the day, and this accounts for the difficulty in finding the open flowers.

Other interesting plants of rocky areas are *Melhania incana* with yellow buttercup-like flowers and a minute species of *Oldenlandia* with forget-me-not

blue flowers on a plant no more than an inch high. This was found only on one small island, namely South Delta, in rock crevices at the top of a moderately high cliff.

Plants of the beaches include the only crucifer to be found on the islands, *Lepidium pedicellosum*, which frequents the shore just above the high tide mark and *Frankenia pauciflorum* which was often the only plant to be seen in the more exposed parts subject to salt spray. *Sesuvium portulacastrum*, a succulent with pink to mauve flowers in the leaf axils, also skirts the high tide mark and on the sandy beaches the ubiquitous prickly saltwort *Salsola kali* is abundant. It occurs in a great variety of forms such that two extremes would be taken to be entirely different species, and yet all intermediate forms may be found.

On the sand dunes the principal consolidating plant is *Spinifex longifolius* with globular fruiting heads which fall off and are distributed by rolling before the wind. The most conspicuous plant in these areas is *Ipomaea pes-caprae*, a trailing plant with large pink convolvulus flowers and two-lobed leaves. Very long prostrate stems are formed, sometimes stretching for many yards without leaves or flowers and looking like so much old rope, and breaking out at the end with a tuft of foliage and perhaps some flowers. These trailing stems sometimes cover large areas of otherwise bare sand.

Other plants of the sand dunes are *Pimelea ammocharis*, forming a hemispherical bush with a flat top covered with sweetly-scented yellow flowers, the sides of the bush being covered with minute silvery leaves, and *Sarcostemma australe* with cylindrical grey leafless stems, terminated in some cases with groups of cream coloured flowers. The stems of this species, like most of this family, exude a thick milky juice when broken.

A few of the plants from the islands are of possible horticultural value, one of these being a species of *Calandrinia*, close to *C. polyandra*. This little succulent has a basal tuft of cylindrical pinkish leaves and six-inch stems topped with from one to five flowers an inch across and of a delicate rose-pink colour. Plants brought home flowered in the author's greenhouse (May 1953). It was found only in one small area on Alpha Island between the beach and the sand dunes.

Plants to be found in the areas farther from the sea include another succulent, *Portulaca intraterranea* with yellow flowers. This has not so far proved very amenable to cultivation in this country, but a *Solanum* species close to *S. esuriale* has germinated from seed collected by the expedition and it is hoped to flower it this summer. It is a neat little plant, about 6 in. high with ovate leaves covered with yellowish felt and bearing mauve flowers about $1\frac{1}{4}$ in. diameter and having the petals frilled at the edges.

The first flowering plant to be seen as the shore was approached for the first time was *Trichinium exaltatum*. This genus is widespread on the mainland where the pink everlasting flowers are known as the Mulla-mulla. A good plant will produce some hundreds of flower heads, each one and a half inches in diameter by four inches long, fluffy white and tipped with pink. In the Islands the white tends to become soiled by blown sand, but in cultivation it should be quite attractive. Growing alongside the Mulla-mulla and providing a colour contrast is *Trichodesma zeylanicum*, very much like a garden Anchusa with inch wide bright blue flowers, the plant growing up to four feet in height in the more sheltered places.

Many of the plants to be found in the inland sandy areas also occurred as rock crevice plants, examples being *Corchorus walcotti* which has already been mentioned as the host plant of a gall fly. A very widely distributed plant is *Abutilon exoneum*, a shrub with cordate hairy leaves and yellow flowers, and by contrast another yellow-flowered plant *Tribulus occidentalis* was found

only on South East Island, where it is very plentiful, covering large areas with its pink hairy stems and greyish pinnate foliage liberally interspersed with the yellow flowers about one and a half inches across.

Two members of the Compositae occur fairly abundantly, *Pterigeron decurrens* having mauve flowers and aromatic foliage and *Pterocaulon sphaeranthoides*, which, as its name implies, has spherical heads like a miniature globe thistle. The latter plant very often has the appearance of having been burnt, the lower leaves and stems being blackened and the upper leaves crinkled as if scorched. In the drier parts, such as the larger part of Trimouille, the dominant plants are species of *Scaevola*, which cover considerable areas like heather on a British moorland, and having a similar tough, wiry constitution. They bear large numbers of blue, white or purple flowers of the assymmetrical form characteristic of the family. At least five species occur in the Islands. Trimouille also supports a number of species of *Acacia*, mostly low-growing species, but one, *A. coriacea*, is one of the largest shrubs on the islands, reaching 4 to 5 feet.

The dodder, *Cuscuta australis* was found growing on a species of *Euphorbia*, but appears to be rare as it was found only once.

One of the very few plants of possible food value to be found is *Canavalia rosea*, a trailing bean with racemes of pink flowers developing into pods up to six inches long by an inch broad with numerous brown beans resembling the beans grown as fodder in this country. Many other leguminous plants are to be found, the Leguminosae being easily the family with the largest number of species in the Islands. *Swainsona* and *Indigofera* are each represented by several species.

The mangrove swamps occur in all the more sheltered bays, and the location of some of them is indicated on the map. They vary in size from small areas with one or two trees to about ten acres with many. They are mostly on thick mud and extremely difficult to penetrate. In one place the trees have been cleared from a bay, apparently for the purpose of culture of pearls, the entrance to the bay having been walled up and a sluice gate fitted. This has now fallen in ruins and the mangroves are regenerating, and here the young trees can be seen growing in conditions in which they are not crowding each other as they do in the well-established colonies. A typical mangrove swamp is shown in Pl. 1 (fig. 3).

The species represented include *Rhizophora mucronata*, *Ceriops tagal* and *Bruguiera rheedii*. The trees form a sanctuary for many of the small birds and the mud is inhabited by many forms of burrowing crabs and lizards.

The distribution of plants in the Island presents some interesting problems. On South East Island are to be found several plants not found elsewhere in the group. These include *Tribulus occidentalis*, a species of *Nicotiana*, and *Atriplex semilunaris*. The flora of East Hermite, separated from the main part of Hermite by a gap of only 15 feet, shows more affinity with that of Trimouille than that of Hermite, but this may be due to the fact that, like Trimouille, it is largely covered with blown sand. Here a very common plant is a species of *Swainsona* which is very widely distributed over all the islands except Hermite, on which it was not found at all. Another species, *S. occidentalis*, occurs only on East Hermite, where a *Goodenia* species is also to be found. This is to be found also on Alpha Island and is scarce on Trimouille. Alpha Island is interesting in that all plants seem to grow bigger and better there. *Polanisia viscosa* is much stronger and larger flowered there than on Hermite, and the form of *Striga multiflora* which occurs there is very vigorous and of a good rose-pink colour, whereas the form to be found on Trimouille is small and has pallid mauve-pink flowers.

A very short visit, lasting only about two hours, was paid to Barrow Island, a much larger island than any in the Monte Bello group. It lies some 40 miles

to the south-west. Wallabies were to be seen and probably two other species of mammal which could not be seen well enough for an attempt to be made at identification. Some lizards were collected, and some 20 plants different from those to be found in the Monte Bello Islands.

In conclusion I should like to acknowledge with thanks the help afforded by the following :—

The Director, Atomic Weapons Research Establishment, for permission to publish this paper.

Commander G. Wedd, R.N., who helped to organize the collection and did most of the marine collecting.

Commissioned Bos'un H. Barns who did much valuable work collecting insects and other invertebrates.

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APPENDIX I

VERTEBRATE FAUNA

Species marked with an asterisk were recorded by P. D. Montague (1914).

MAMMALIA.

*Eptesicus pumilus (Gray).

AVES.

Falco cenchroides Vigors and Horsfield.
*Geopelia humeralis humeralis (Temminck).
*Lichmera indistincta perplexa (Mathews).
*Halcyon sancta westralasiana Campbell.
*Charadrius alexandrinus ruficapillus Temminck.
Egg of Orthorhamphus magnirostris. (Vieillot).

REPTILIA.

SAURIA.

*Peropus variegatus (Dumeril and Bibron).
*Heteronota bineoei (Gray).
*Physignathus gilberti (Gray).
Amphibolurus caudicinctus (Gunther).
*Varanus gouldi (Gray).
*Sphenomorphus lesueurii (Dumeril and Bibron).
*Lygosoma (Rhodona) bipes (Fischer).
Ablephanus sp.
Lialis burtoni (Gray).
Aprasia sp.

SERPENTES.

*Liasis childreni (Gray).
Demansia psammophis (Schlezel).
Pseudelaps christeanus ? (Fry).
Hydrophis elegans (Gray).
H. ornatus ocellatus (Gray).
Astrotia stokesi (Gray).
Aipysurus laevis (Lacépède).

PISCES.

SELACHII.

Carcharinus sp.

INIOMI.

Synodus variegatus (Lacépède).

APODES.

Muraena (Gymnothorax) picta Ahl.
Caecula sp.

PERCOMORPHI.

Epinephelus fasciatus (Fôrskal).
Epinephelus sp.
Chelmo rostratus marginalis Richardson.
Abudefduf palmeri (Ogilby).
Abudefduf sordidus (Forskal).
Choerodon cyanodus (Richardson).
Thalassoma lunare (L.).
Siganus virgatus (C.V.).
Asterropteryx semipunctatus (Rüppell).
Gobius ornatus (Rüppell).
Bathygobius fuscus (Rüppell).
Callionymus japomicua (Houttuyn).
Salarias lineatus (C.V.).
Salarias edentulus (Bloch Schneider).
Salarias sp.
Crenalticus meleagris (C.V.).
Petroscirtes obliquus (Garman).
Petroscirtes? kallosoma (Bleeker).
Petroscirtes sp.
Tripterygion sp.

SCLEROPAREI.

Scorpaena bynoensis (Rishardson).

PLECTOGNATHI.

Lactoria diaphanus (Bloch Schneider).
Tetraodon reticularis (Bloch Schneider).

HAPLODOCI.

*Halophryne diemensis (Le Sueur).

APPENDIX II
INSECT FAUNA

THYSANURA.

LEPISMATIDAE.
- Lepisma saccharina L.
- Acrotelsella sp.

COLLEMBOLA.

- Pseudanurida australica Salmon

ORTHOPTERA.

PHASMIDAE.
- Hyrtacus peridromes (Westwood)
- 4 unidentified.

BLATTIDAE.
- 15 unidentified.

MANTIDAE.
- Orthodera austaliana Giglio-Tos
- Bolbe sp.
- Truxomantis sp.
- Mantis octospilota (Westwood)
- Austrovates variegata Sjöstedt
- Austrovates sp.
- 1 unidentified.

TETTIGONIIDAE.
- 2 unidentified.

GRYLLIDAE.
- Gryllodes sigillatus (Walker)
- 3 unidentified.

ACRIDIIDAE.
- Valanga irregularis (Walker)
- Austracris sp.
- Goniaeoidea sp.
- Urnesiella rubropunctata Sjöstedt
- 12 unidentified.

EUMASTACIDAE.
- 12 unidentified.

ISOPTERA.

TERMITIDAE.
- Nasutitermes triodiae Harris

HEMIPTERA.

PENTATOMIDAE.
- Novatilla sp. n.
- Sciocoris rubens Distant ?
- Sciocoris sp.
- Cephaloplatus sp.

CYDNIDAE.
- Cydnus dilatatus Sign.
- Cydnus sp.

LYGAEIDAE.
- Nysius sp. (nymph).
- Oxycarenus arctatus Walker
- Dienches distanti Bergroth

MIRIDAE.
- Engytatus nicotianae (Konigsberger)
- Creontiades modestum (Distant)

GERRIDAE.
- Halobates mjöbergi Hale
- Halobates regalis Carpenter
- Hermatobates haddoni Carpenter
- Hermatobates sp. n.

VELIIDAE.
- Halovelia sp. n.

CICADIDAE.
- nymph.

CICADELLIDAE.
- Eurinoscopus translucidus Evans
- Tartessus spinosus Evans
- Tartessus sp. n.

FLATIDAE.
- Siphanta sp. n.

ISSIDAE.
- Campelopterum sp.

TETTIGOMETRIDAE.
- Gen. nov. et sp. n.

NEUROPTERA.

MYRMELEONIDAE.
- Eophanes falcata Kimmins

CHRYSOPIDAE.
- Calochrysa extranea (Esben-Petersen)
- Chrysopa ramburi Schneider
- Chrysopa eremita
- Chrysopa sp. (larva).

LEPIDOPTERA.

PIERIDAE.
- Anaphaeis java teutonia Fabricius
- Eurema smilax Donovan.

NYMPHALIDAE.
- Precis villida Fabricius

ACRAEIDAE.
- Acraea andromacha Fabricius

LYCAENIDAE.
- Lampides boeticus L.
- Zizeeria otis Fabricius
- Nacaduba biocellata Felder
- Theclinesthes onycha Hewitson
- Holochila heathi aerata Montague

HESPERIIDAE.
- Anisyntoides argenteo-ornatus ssp. insula Waterhouse

SYNTOMIDAE.
- Syntomis chroma Swinhoe
- Syntomis aperta Walker

ARCTIDAE.
- Lambula sp.
- Amsacta marginata Donovan
- Utetheisa pulchelloides Hampson

NOCTUIDAE.

Neocleptria punctifera Walker
Heliothis rubrescens Walker
Euxoa radians Guénée
Propatria neuroides Swinhoe
Ectopatria paurogramma Lower
Ectopatria aspera Walker
Prodenia litura Fabricius
Hypoperigea tonsa Guénée
Eublemma rivula Moore
Eublemma dubia Butler
Earias huegeli Rogenhofer
Earias parallela Lucas
Earias insulana Boisduval
Anua tirhaca clementsi Swinhoe
Grammodes ocellata Tepper
Achaea janata argilla Swinhoe
Eudesmeola lawsoni Felder
Catephia canescens Hampson
Prorocopis sp.
Pandesma submurina Walker
Dasypodia selenophora Guénée
Plecoptera sp.

SPHINGIDAE.

Herse convolvulii L.
Cephonodes kingii McLeay.
Hippotion celerio L.

LYMANTRIIDAE.

Euproctis sp.

ANTHELIDAE.

Anthela sp.
Anthela pudica Swinhoe

GEOMETRIDAE.

Toxeotis sp.
Eucrostes disparata Walker
Prasinocyma ocypter Meyrick
Prasinocyma sp.
Scopula homodoxa Meyrick
Scopula subcandida Prout
Cleora sp.

PSYCHIDAE.

Plutorectis sp.

PYRALIDAE.

Nephopterix ? infusella Meyrick
Laodamia flavitinctella Ragonot
Salebria ? morosalis Saalmüller
Salebria sp. 1.
Salebria sp. 2.
Oligochroa oculiferella Meyrick
Oligochroa ? digramella Meyrick
Cateremna microdoxa Meyrick
Etiella chrysoporella Meyrick
Etiella behrii Zeller
Etiella ? sincerella Meyrick
Trissonca mesactella Meyrick
Euzophera sp.
Homoeosoma sp.
Specatrota fimbrialis Warren
Eclipsiodes sp.
Cataclysta sp.
Voliba sp.
Ercta chalybitis Meyrick
Hymenia recurvalis Fabricius
Lamprosema leonina Butler

PYRALIDAE (*cont.*)

Lygropia xanthomela Meyrick
Margaronia indica Saunders
Metasia homogama Meyrick
Hellula hydralis Guénée.
Nomophila noctuella Schiffermüller & Denis
Loxostege affinitalis Lederer
Pyrausta incoloralis Guénée
Sceliodes cordalis Doubleday

COLEOPTERA.

CARABIDAE.

Calosoma schayeri Erichson
Lebia sp.

STAPHYLINIDAE.

Scimbolium uniformis Cameron

COCCINELLIDAE.

Coccinella repande

DERMESTIDAE.

Dermestes ater Degeer.

ELATERIDAE.

Incomplete specimen of a new genus and species near Coptostethus.

TENEBRIONIDAE.

Saragus sp.
Helaeus derbyensis Macleay
Omolipus oblongus Bates
Micrectyche ferruginea Bates

MALACHIIDAE.

Laius purpuripennis Lea

SCARABAEIDAE.

Liparochrus sp.
Heteronyx parralus Macleay
Allara insularis Britton
Neodon novitius Blackburn

CERAMBYCIDAE.

Symphyletes sp.

CURCULIONIDAE.

Myllocerus nasutus Pascoe
Hypolixus copiosus Lea

BRUCHIDAE.

Bruchidius persimulans Blackburn

HYMENOPTERA.

FORMICIDAE.

Camponotus sp. 1.
Camponotus sp. 2.
Melophorus sp. 1.
Melophorus sp. 2.
Odontomachus sp.
Polyrhachis sp. 1.
Polyrhachis sp. 2.
Polyrhachis sp. 3.
Opisthopsis sp. ? haddoni rufonigra Forel (taken in termites nest).
Iridomyrmex sp. 1 (taken in termites nest).
Iridomyrmex sp. 2 (taken in termites nest).

THYNNIDAE.
Males and females of an undetermined genus.

MUTILLIDAE.
Ephutomorpha sp.

SCOLIIDAE.
Campsomeris tasmaniensis Saussure
Campsomeris sp.

POMPILIDAE.
Platyderes collaris Fabricius
Cryptocheilus tuberculatus Smith
1 unidentified.

SPHECIDAE.
Bembex sp.

COLLETIDAE.
Paracolletes sp. 1.
Paracolletes sp. 2.

HALICTIDAE.
Halictus sp. 1.
Halictus sp. 2.

MEGACHILIDAE.
Megachile sp.

ICHNEUMONIDAE.
Netelia sp.
Cremastus sp.

BRACONIDAE.
Rhogas (s.l.) sp.
Opius (s.l.) sp.

GASTERUPTIONIDAE.
Rhydenofoenus sp.

DIPTERA.

TIPULIDAE.
Limonia sp.

CHIRONOMIDAE.
Damaged, indet.

CULICIDAE.
Anopheles sp.

CECIDOMYIIDAE.
16 specimens to be identified.

TABANIDAE.
Ectenopsis sp. n.
Some specimens not yet identified.

ASILIDAE.
Cerdistus sp.
Neosaropogon sp.
Chrysentria sp.
Miltinus minutus Mackerras
Leptogaster sp.
Ommatius spp. not yet identified.

THEREVIDAE.
Unidentified.

BOMBYLIIDAE.
Hyperalonia bombylifrons Mackay
Exoprosopa adelaidica Macquart
Anthrax semimacula Walker
Some specimens not yet identified.

SYRPHIDAE.
Syrphus pusillus Macquart

ORTALIDAE.
Specimen not yet identified.

TRYPETIDAE.
Specimens not yet identified.

LAUXANIIDAE.
Specimens not yet identified.

TACHINIDAE.
Chrysorutilia formosa R–D.
Specimens not yet identified.

MUSCIDAE.
Specimens not yet identified

APIOCERIDAE.
Apiocera newmani Norris

APPENDIX III

FLORA

CRUCIFERAE.
Lepidium pedicellosum F. Muell.

CAPPARIDACEAE.
Capparis nummularia DC.
Polanisia viscosa (L.) DC.

FRANKENIACEAE.
Frankenia pauciflora DC.

CARYOPHYLLACEAE.
†Polycarpaea longiflora F. Muell.

PORTULACACEAE.
Portulaca intraterranea J. M. Black
Calandrinia sp. near C. polyandra Benth.

MALVACEAE.
Malvastrum spicatum (L.) A. Gray
Abutilon indicum G. Don var. *australiense* Hochr.
Abutilon exoneum F. Muell.
Abutilon sp. near A. asiaticum (L.) Sweet
Sida pedunculata Domin
Plagianthus glomeratus (Hook.) Benth.
Hibiscus sturtii Hook.

STERCULIACEAE.
Melhania incana Heyne

TILIACEAE.
Corchorus walcottii F. Muell.
† Triumfetta ramosa Sprague and Hutch.

ZYGOPHYLLACEAE.
Tribulus occidentalis R. Br.

SAPINDACEAE.
†Diplopeltis eriocarpa Hemsl.
Heterodendron oleaefolium Desf.

LEGUMINOSAE.
Indigofera linifolia (L.f.) Retz.
I. viscosa Lam.
I. trita L.f.
†I. monophylla DC.
Swainsona kingii F. Muell.
Swainsona sp.
S. occidentalis F. Muell.
Psoralea clementii Domin
Rhynchosia minima (L.) DC.
Crotalaria trifoliastrum Willd.
Tephrosia clementii Skan
T. supina Domin
Canavalia rosea (Sw.) DC.
Cassia sp.
Acacia coriacea DC.
A. bivenosa DC.
Acacia spp.

ROSACEAE.
†Stylobasium spathulatum Desf.

RHIZOPHORACEAE.
Rhizophora mucronata Poir.
Ceriops tagal C. B. Rob.
Bruguiera rheedii Bl.

MYRTACEAE.
Melaleuca cardiophylla F. Muell.

FICOIDACEAE.
Sesuvium portulacastrum (L.) L.

RUBIACEAE.
Oldenlandia sp. near O. crouchiana F. Muell.

COMPOSITAE.
Flaveria australasica Hook.
Vittadinia scabra DC.
Pterocaulon sphaeranthoides DC.
Olearia axillaris F. Muell.
Launaea sarmentosa (Willd.) Alston
Pterigeron decurrens DC.
Pterigeron spp.
†Pluchea rubelliflora (F. Muell.) J. M. Black
†Chrysogonum trichodesmoides F. Muell.

GOODENIACEAE.
Scaevola spinescens R. Br.
S. cunninghamii DC.
S. cunninghamii DC. var. hispida Benth.
S. crassifolia Labill.
†S. sp. near S. glandulifera.
Scaevola sp.
Goodenia sp. near G. heterochila F. Muell.

PLUMBAGINACEAE.
Statice salicorniacea F. Muell.

OLEACEAE.
†Jasminum calcareum F. Muell.

ASCLEPIADACEAE.
Sarcostemma australe R. Br.
Cynanchum floribundum R. Br.

BORAGINACEAE.
Trichodesma zeylanicum (Burm. f.) R. Br.
†Heliotropium sp. near H. ovalifolium Forsk.

CONVOLVULACEAE.
Evolvulus alsinoides (L.) L.
Breweria media R. Br.
Ipomoea pes-caprae (L.) R. Br.
Cuscuta australis R. Br.

SOLANACEAE.
Solanum sp. near S. esuriale Lindl.
†S. lasiophyllum Dun.
S. ellipticum R. Br.
Nicotiana sp.
N. sp. ?

SCROPHULARIACEAE.
Striga multiflora Benth.

ACANTHACEAE.
Ruellia sp.

MYOPORACEAE.
Myoporum acuminatum R. Br. var.

VERBENACEAE.
†Avicennia eucalyptifolia Zipp.
A. marina Vierh. var. resinifera (Forst.) Bakh.

NYCTAGINACEAE.
Boerhavia diffusa L.
Boerhaavia sp.
Commicarpus chinensis (L.) Heimerl.

AMARANTHACEAE.
Amaranthus pallidiflorus F. Muell.
Ptilotus villosiflorus F. Muell.
Trichinium exaltatum Benth.
†T. obovatum Gand.

CHENOPODIACEAE.
Chenopodium carinatum var. holopterum (Thell.) Aellen.
Atriplex semilunaris Aellen.
A. cinerea Poir.
Atriplex sp.
Arthrocnemon sp.
Bassia astrocarpa F. Muell.
Bassia sp.
Threlkeldia diffusa R. Br.
Enchylaena tomentosa R. Br.
Salsola kali L.

THYMELAEACEAE.
Pimelea ammocharis F. Muell

EUPHORBIACEAE.

Euphorbia coghlani F. M. Bailey
E. drummondii Boiss.
E. australis Boiss. var.
E. eremophila A. Cunn.
E. sp. ? E. alsinaeflora Baill.
Phyllanthus maderaspatanus L.
P. sp. near P. feurnrohrii F. Muell.
Phyllanthus sp.
Adriana tomentosa Gaud.

URTICACEAE.

Ficus platypoda A. Cunn.

JUNCACEAE.

Acanthocarpus preissii Lehm.

CYPERACEAE.

†Mariscus cunninghamii C. B. Clarke

GRAMINEAE.

Spinifex longifolius R. Br.
Paspalidium nov. sp. ?
Setaria dielsii Herrm.
Triraphis mollis R. Br.
Eragrostis sp.
Sporobolus virginicus (L.) Kunth
Eulalia fulva (R. Br.) O. Kuntze
Sorghum plumosum (R. Br.) Beauv.
Eriachne sp.
Enneapogon lindleyanus (Domin) C. E. Hubbard
Aristida browniana Henrard
Triodia wiseana C. A. Gardner

† indicates that the species was collected on Barrow Island which is not one of the Monte Bello group.

COLEOPTERA : SCARABAEIDAE : MELOLONTHINAE AND DYNASTINAE FROM THE MONTE BELLO ISLANDS, 1952

By E. B. BRITTON.
Department of Entomology, British Museum (Natural History).

(With 3 text-figures.)

MELOLONTHINAE.

Heteronyx parvulus Macleay.

Monte Bello Islands : Hermite I., 20. viii. 52, 1 ex. ; 25. viii. 52, 1 ex. ; 27. viii. 1952, 1 ex. ; 10. ix. 52, 1 ex. at light. Hermite and Trimouille Is., viii–x. 1952, 1 ex.

This species is known only from N.W. Australia. The type locality is King Sound.

Allara gen. nov.

Posterior tibiae strongly expanded to their apices (ratio length/width at apex ca. 2·0), with a complete transverse setose ridge on the outer face ; the two terminal spurs of the posterior tibiae set in an emargination of the inner apical edge of the tibia, one on each side of the basal segment of the tarsus which is free to move between the spurs ; the spurs slender, about as long as the basal segment of the tarsus ; tarsal claws simple and symmetrical ; anterior coxae projecting to a distance equal to the width of the anterior coxal cavity ; posterior coxae convex and thickened towards the outer sides and about one-half as long as the metepisternum ; posterior femora very broad (ratio length/greatest width ca. 1·65) ; anterior tibia with a single large acute tooth on the outer edge in addition to the long slender apical process ; labrum not visible from above, fused to the clypeus ; clypeus not emarginate near the base at each side ; tergite and sternite of the penultimate abdominal segment completely separated by a longitudinal suture on each side ; sides of the abdomen without a longitudinal ridge ; antenna 8-semented including a 3-segmented club ; maxillary palpi rather long, the terminal segments approximately cylindrical and truncate ; labial palpi very small ; elytra covering the propygidium ; colour not metallic, mesosternum without a median process.

Type species : *Allara insularis* new species.

Allara is more closely related to the genera included in the Colpochilini and the Systellopini than any of the other tribes. It resembles the Colpochilini

and differs from the Systellopini in having a 3-lamellate antennal club and in the absence of an emargination of the edge of the clypeus above the basal articulation of the antenna. On the other hand it resembles the Systellopini and differs from the Colpochilini by its greatly expanded posterior tibiae, which have a complete transverse setose ridge (the ridge is absent in the middle in the Colpochilini), by the inflated posterior coxae and femora, and the reduced labial palpi. The genus, however, differs from both Colpochilini and Systellopini by the fact that the labrum is fused with the clypeus. In the Colpochilini the labrum is placed below, and is almost always very distinctly separated from the clypeus. In the Systellopini the labrum is unusually large and thick and extends forwards in front of and more or less in the same plane as the clypeus. The Systellopini constitute a very well-defined tribe and the genus *Allara* cannot be regarded as uniting the Systellopini and the Colpochilini. The systematic position of *Allara* is therefore best displayed by the creation of a new tribe, the Allarini which takes a position between the Colpochilini and the Systellopini.

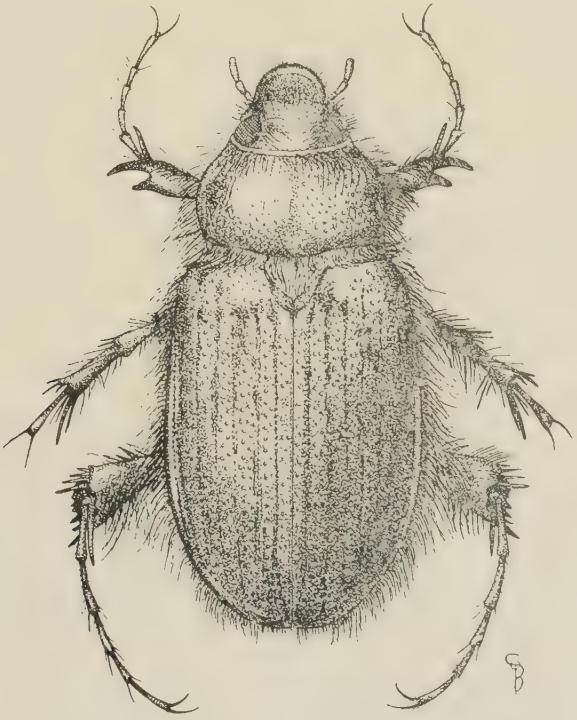

Fig. 1.—*Allara insularis*, gen. et sp. nov.

Allara insularis, sp. nov.

Figs. 1, 2, 3. Length : ca. 10 mm.

Whole insect reddish brown, except the posterior edges of the anterior tibiae and the apical edges of the mid and posterior tibiae which are black ; the head darker in colour than the pronotum ; all setae of a pale golden colour. *Clypeus* almost semicircular in outline, slightly pointed in the middle in front and slightly concave at the sides near the base ; anterior and lateral margins reflexed ; basal half coarsely and closely punctured, each puncture bearing a short pointed seta ; anterior half with sparse, minute non-setiferous

punctures. *Frons*: anterior half closely punctured, the punctures non-setiferous except at each side near the upper edge of the eye where the punctures bear long setae which almost meet over the middle of the frons; posterior half of the frons unpunctured. *Pronotum*: ratio greatest width to middle length 1·65; anterior angles approximately square, posterior angles broadly rounded; anterior edge with a darker thickened margin defined by a groove in which is a close set fringe of long setae like those above the eyes; the thickened margin continued forwards into a narrow transparent membranous margin; disc with numerous coarse setiferous punctures on each side of the middle in the anterior half other parts of the surface of the prototum with fine sparse non setiferous punctures; posterior and lateral edges with a fine raised margin along the inner side of which is set a dense fringe of long fine setae; posterior edge of the thorax densely clothed with long fine soft setae. *Scutellum*: large, rounded, with setiferous punctures on the basal half, the apical half smooth and unpunctured. *Elytra*: the sutural stria strongly impressed in the apical three-quarters of its length and finely punctured; remaining striae marked by fine punctures spaced by two to five times their diameter; similar punctures are sparsely distributed on the intervals between striae; intervals 1, 3, 5, 7 and 9 are very slightly convex and about half as wide as the adjacent intervals; surface shining; extreme lateral and apical edges with a very close fringe of very short soft pale yellow setae, the lateral and apical margins bearing a sparse fringe of stout stiff setae. Pygidium moderately convex, clothed with very long fine soft setae. *Labrum* approximately semi-circular when seen from in front, distinct but fused to the lower anterior face of the clypeus; its surface closely punctured and bearing short stout setae like the lateral faces of the clypeus. *Maxillary palpi* (fig. 3) with terminal segments subcylindric and truncate. *Labial palpi* very small, the apical segments conical. *Mentum* moderately convex, densely setose at the sides. *Antennae* with the two basal segments densely punctured and setose. *Ventral surface*: clothed with dense, long, fine setae.

Fig. 2. Fig. 3.

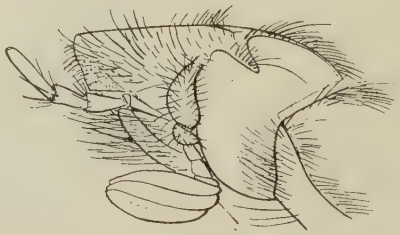

Fig. 2.—*Allara insularis*, gen. et sp. nov. Outer face of posterior tibia.
Fig. 3.—*Allara insularis*, gen. et sp. nov. Side view of head.

Monte Bello Islands: Hermite I., ix. 52; holotype, Geraldton, xi. 15 (J. Clark), paratype.

One paratype without locality in the West Australian Museum.

Dynastinae.

Neodon novitius Blackburn.

Monte Bello Islands: Hermite and Trimouille Is., viii–x. 52, 10 ex. Hermite I., 16–25. viii. 52, 5 ex. The species is known from the mainland.

Species determined by Mr. P. Carne.

COLEOPTERA: COCCINELLIDAE FROM THE MONTE BELLO ISLANDS, 1952

By R. D. Pope.
Commonwealth Institute of Entomology, London, S.W.7.

(With 1 text-figure.)

Coccinella repanda Thunberg

This species is widespread throughout Asia and is also known from Australia and New Zealand.

Three examples were collected in the Monte Bello Islands with data as follows :—

Monte Bello Islands : Hermite I., viii–x. 1952 (Coll. H.M.S. *Campania*).

Fig. 1.—*Brumus maculatus* sp. nov., elytral pattern.

Brumus maculatus sp. nov.

Length 3·4–3·5 mm. Breadth 2·5–2·6 mm.

Oval, convex ; testaceous with a dark sutural band and three dark spots on each elytron (fig. 1), metasternum and base of abdomen darker than prosternum and abdominal apex ; *head* with anterior clypeal border emarginate medially, inner borders of eyes almost straight, divergent toward vertex, surface finely and rather sparsely punctured, intervals finely reticulate ; *pronotum* with anterior border above eyes and lateral borders narrowly reflexed, disc more finely and sparsely punctured than head, intervals finely reticulate ; scutellum small, triangular, feebly transverse, very finely punctate ; *elytra* as long as broad, humeral calli moderately well marked, lateral margins with reflexed border from bases almost to apicosutural angles which are rounded, disc shallowly and sparsely punctured, separation by up to five diameters, punctures coarser and closer along lateral margins, intervals finely reticulate ; prosternum with intercoxal process convex, not carinate ; mesosternum with anterior margin bordered, entire ; metasternum rather short, black, with a longitudinal median sulcus ; abdominal segments markedly pubescent, abdominal plates occupying almost three-fourths of the length of the first segment, complete, fifth ventrite truncate apically in *male*, somewhat arcuate in *female* ; *legs* yellowish testaceous.

Monte Bello Islands : Hermite I., viii–x. 1952 (Coll. H.M.S. *Campania*). Type ♂.

Paratypes (2 ♂ and 2 ♀) with same data as type.

Comparative notes : This is the first species of *Brumus* to be described from Australasia. Superficially it resembles *septentrionis* Weise in elytral colour pattern, but in the latter species the pronotum is black. Also in *septentrionis* the punctation is more readily visible and the reticulation of the intervals stronger.

COLEOPTERA : STAPHYLINIDAE FROM THE MONTE BELLO ISLANDS, 1952

By Dr. Malcolm Cameron.

Scimbalium uniformis sp. nov.

Moderately shining, black. Antennae and palpi black. Legs reddish yellow. Length 7 mm. Near *bodium* Motsch. but differs in the much coarser and closer puncturation of the head and thorax and stronger ground sculpture, the much shorter antennae, the shorter black, more strongly punctured elytra and less finely punctured abdomen.

Head distinctly broader than the thorax, a little broader than long, the posterior angles rounded, the eye about as long as the temple, along the middle narrowly impunctate, elsewhere (except the front) very closely, moderately coarsely punctured; ground sculpture coriaceous. Antennae with 2nd segment shorter than the 3rd, 4th and following slightly longer than broad, gradually decreasing in length. Thorax a little longer than broad, broader in front, the anterior angles rounded, the sides distinctly retracted and slightly sinuate to the base, along the middle impunctate, elsewhere very closely punctured, the punctures rather finer than those of the head, the ground sculpture similar. Elytra broader and distinctly longer than the thorax, very closely and much more finely asperately punctured and without ground sculpture. Abdomen less finely but as closely punctured as the elytra, not asperate; ground sculpture absent.

♂: sixth ventral segment triangularly excised, the apex of the excision rounded.

Monte Bello Islands: viii–x. 1952 (Hermite and Trimouille). Holotype and 2 paratypes.

NEUROPTERA FROM THE MONTE BELLO ISLANDS, 1952

By D. E. Kimmins.

Department of Entomology, British Museum (Natural History).

(With 2 text-figures.)

This Order is represented by 20 examples of the two families, Myrmeleonidae and Chrysopidae. Two of the four species appear to be new to science and are described in this paper; the other two species have a wide distribution in Australia. The neuropterous fauna of Western Australia has been but little collected or studied, and it seems probable that both the new species dealt with here will also be found at least in Western Australia.

Myrmeleonidae.

Eophanes falcata sp. nov.

Monte Bello Is.: Hermite I., 1. x. 1952 (♂ Holotype).

Monte Bello Is.: Hermite and Trimouille Is., viii–x. 1952 (♀ Allotype).

Head fulvous, a transverse fuscous band on the frons at the level of the antennal bases, its lower outer angles extended downwards in acute points, vertex only obscurely spotted with fuscous. Eyes grey. Antenna yellowish brown, becoming more reddish towards the gradually clubbed apex. Palpi yellowish brown, apical segments more reddish. Thorax fulvous, pronotum with two small, obscure, brownish spots on each side. There is a faint pinkish

suffusion of the thorax, possibly the result of post-mortem changes. Legs moderately stout, pale fulvous, with black setae and ventrally on trochanter and base of femur (more particularly the anterior) a dense patch of blackish pubescence. Spurs reddish brown, curved, longer than first four tarsal segments.

In the ♂, abdomen rather shorter than hind wing, slender, pale fulvous, tergites marked as follows :—Second entirely fuscous with the exception of a short, transverse, basal spot, narrower than the segment ; segments three to four with apical half and two median spots fuscous, five to six with apical half and only one median spot fuscous, seven and eight entirely fuscous ; ventrally luteous. In the allotype ♀, segments three and four have only one median fuscous spot instead of two.

Wings rather broad, dilating gradually from base to beyond half-way, then tapering to somewhat falcate apices, the shallow excision of the margin being just behind the termination of Sc + R_1. Apical area broad, with a single row of three or four cross-veins. Membrane hyaline, neuration luteous, with fuscous interruptions on the main veins, many of the cross-veins fuscous and bordered with fuscous. There is a conspicuous, rounded, fuscous spot towards the apex of M_{1+2} in each wing, with a smaller one beyond it (more noticeable

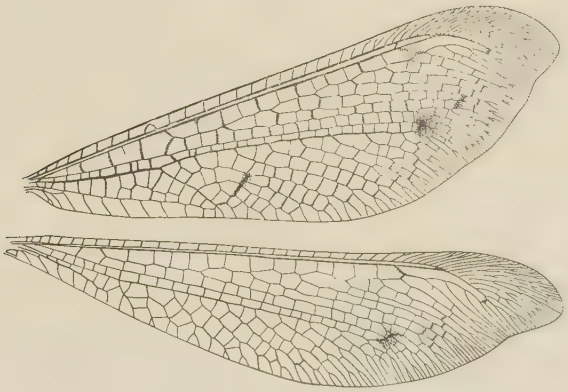

Fig. 1.—*Eophanes falcata* sp. nov. ♂ wings.

in the allotype ♀), an oblique brownish streak in the cubital fork of fore wing and two small brownish spots behind the creamy pterostigma in each wing.

Length of fore wing ♂ 34 mm., ♀ 39 mm.
,, ,, hind ,, ♂ 33 mm., ♀ 39 mm.
,, ,, abdomen ♂ 25 mm., ♀ 25 mm.

Type ♂, allotype ♀ in British Museum (N.H.). This fine insect resembles *Eophanes schädleri* (Weele, 1909) in abdominal marking, wing pattern and venation. It differs in the broader, more falcate wings, broader apical area, and different markings of the head and thorax.

Chrysopidae.

Calochrysa extranea (Esben-Petersen).

1 ♀, Monte Bello Is., upper deck of H.M.S. *Campania*, 14. viii. 1952.

Previously recorded from New South Wales, Queensland, W. Australia and S. Australia.

Chrysopa eremita sp. nov.

2 ♂, 6 ♀, Monte Bello Is., Hermite I., viii–x. 1952.

Head pale yellowish, genae brown, a red line traversing the face below the antennal bases, turning up at each end between eye and antenna, then following the anterior margin of the raised frons and passing down between the antennae but not reaching the transverse line. Posterior margin of frons suffused with reddish. Antenna pale yellowish, basal segment dorsally with a longitudinal brownish stripe, and inward from its apex a brown spot, which may be joined to the stripe; second segment brownish, at least externally. Palpi yellowish to brownish. Pronotum longer than broad, yellow with rounded reddish anterior angles. Meso- and metathorax yellow, metascutum with two small brownish dots. Legs pale yellowish. Abdomen yellow.

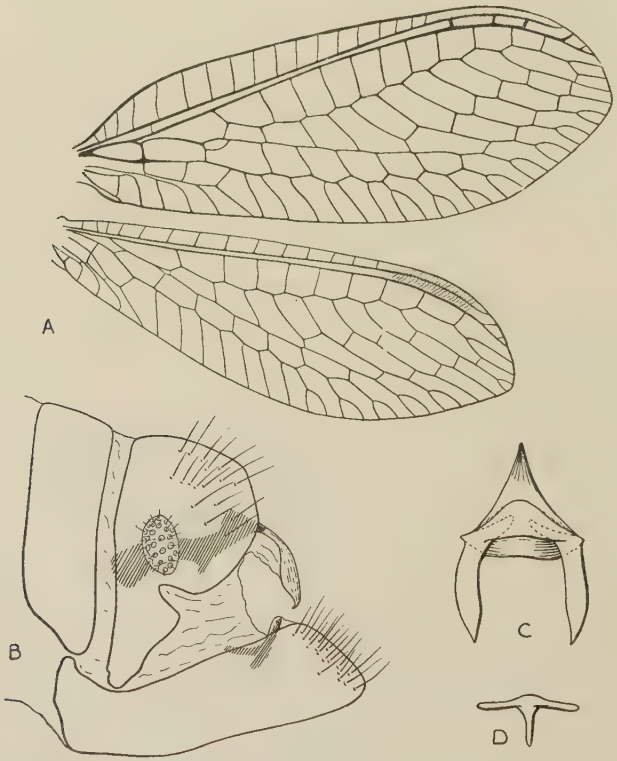

Fig. 2.—*Chrysopa eremita* sp. nov. ♂. A, wings; B, genitalia, lateral; C, fused tenth sternite and aedeagus, dorsal; D, ninth sternite, dorsal.

Wings elongate, hyaline, apices obtusely rounded, main venation yellowish, gradate cross-veins and some of the other cross-veins brownish. Fore wing with the first intra-median cell narrow, extending beyond the first radio-medial crossvein. Gradate series parallel, inner series slightly nearer to outer series than to radial sector.

♂ Genitalia.—Eighth sternite produced in a long, parallel-sided subgenital plate, apex tapered and acutely rounded and within is a small T-shaped, sclerotized plate, possibly the remnant of the ninth sternite. Ninth and tenth tergites fused, forming a pair of inverted pyriform plates, the lower apical

margin with a small acute indentation. Tenth sternite short, arch-shaped, with the aedeagus fused to the apex of the arch. Aedeagus in the form of a thin plate, curving down to an acute tip, in dorsal view triangular, with the sides slightly concave.

Length of fore wing : ♂ 11 mm., ♀ 12–13 mm.

Holotype ♂ (with abdomen mounted in canada balsam), allotype ♀ and paratypes in the British Museum (N.H.). In Banks' key to the Australian species of Chrysopa (1940), this species appears to run out to *C. signata* Schneider, from which it differs in the absence of a black mark between the antennal bases and the different marking on the basal segments of the antennae. The wing venation is more open and there are fewer gradate cross-veins.

Chrysopa ramburi Schneider.

4 ♂, 4 ♀, Monte Bello Is., Hermite I., viii–x. 1952.

Previously recorded from Tasmania, Australia, Samoa, Society Is., Marshall Is.

Chrysopa sp., larva.

1, Monte Bello Is., Hermite I., viii–x. 1952.

COLLEMBOLA : A NEW SPECIES OF PSEUDANURIDA FROM THE MONTE BELLO ISLANDS

By J. T. Salmon.

Victoria University College, Wellington, N.Z.

(With 11 text-figures.)

This species from Hermite Island is closely related on the one hand to *P. billitonensis* Schott and on the other to *P. dollfusi* Denis. It differs from the former in the untoothed nature of the lamella of the hypopharynx, the mandible and the inner margin of the claw ; and from the latter primarily in the inner margin of the claw and the mucro. The mandibles and hypopharynx of *dollfusi* and *australica* are very similar. Types and paratypes of *P. australica* are deposited in the British Museum (Natural History) and paratypes are also in the Author's collection.

Pseudanurida australica sp. nov.

Colour : Entirely deep blue-black except for the ventral surface and furcula which are pale blue.

Clothing : Short and moderately long simple setae, sparse on the body, more numerous posterio-ventrally and on the legs and antennae.

Body : Length up to 1·5 mm. Antennae shorter than the head, the four segments related as 21 : 28 : 35 : 52. Ant. IV with apical finger-like process, two apical exsertile knobs surrounded by 7–9 short, straight, tapering sense rods, and 3–4 longer, curved, subapical sense rods below which the segment is clothed with fairly long, stout, simple setae. No sense organ on Ant. III. Mandible without molar area but with two very large subapical teeth and six smaller teeth in a row towards apex (figs. 1 & 2) ; hypopharynx bulbous with ' V ' shaped untoothed apex ; maxilla slender with ten small teeth and one large subapical tooth (fig. 3). Ocelli eight to each side, all large and equal. Postantennal organ absent. Cuticle strongly granulate. Rami of tenaculum each with three barbs, the corpus coarsely bulbous at apex and with a large secondary triangulate lobe.

Legs: Claw without any teeth but with a moderately long basal seta to each side. Unguiculus reduced to a small projection. Tenent hairs absent.

Furcula: Manubrium to dens to mucro as 14 : 31 : 4. Dens strongly granulate with the mucro-dens joint indistinct; manubrial hooks present and an irregular row of six medium length setae runs down the posterior face. Mucro rather boat-like, the apex rounded and with the dens extending along underneath as a kind of keel which tapers to a point. The two side lamellae fold inwards slightly and one is thickened along its edge.

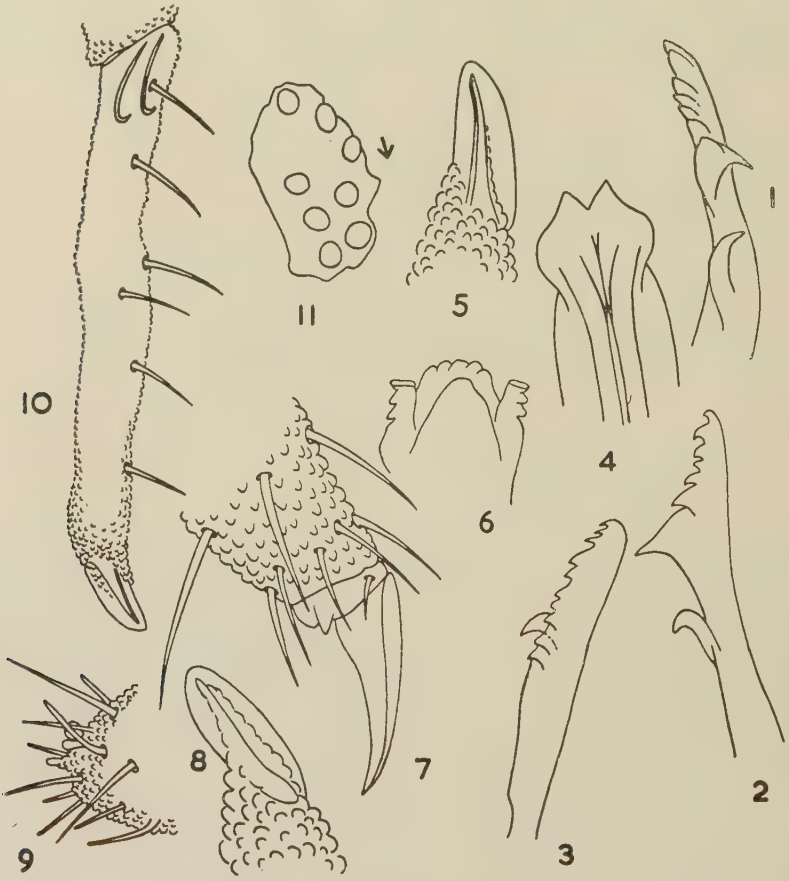

FIG. 1.—Mandible from face from Paratype. ×1260.
FIG. 2.—Mandible from side from Paratype. ×1260.
FIG. 3.—Maxilla from side from Paratype. ×1260.
FIG. 4.—Apex of hypopharynx as seen from above from Paratype. ×1260.
FIG. 5.—Mucro, anterior face, from Type. ×560.
FIG. 6.—Tenaculum from Type. ×560.
FIG. 7.—Hind foot from Type. ×560.
FIG. 8.—Mucro, posterior face from Type. ×560.
FIG. 9.—Apex of Ant. IV from Type. ×560.
FIG. 10.—Dens from Type. ×240.
FIG. 11.—Ocellar group from Type. ×240.

PROCEEDINGS OF THE GENERAL MEETING HELD ON 9 April 1953

Lt.-Col. R. B. Seymour Sewell, C.I.E., F.R.S., President, in the Chair.

The Proceedings of the General Meeting held on 19 March 1953, having been circulated, were taken as read, and confirmed.

The President announced the death of Her Majesty Queen Mary, senior Honorary Member of the Society, and read an Address of Condolence with Her Majesty The Queen, all present rising in their places.

To the Queen's Most Excellent Majesty.

The Humble and Loyal Address of the President and Fellows of the Linnean Society of London.

May it please Your Majesty,

We Your Majesty's most loyal and faithful Subjects, the President and Fellows of The Linnean Society of London in General Meeting assembled, humbly beg leave to offer to Your Majesty and all the Royal Family our heartfelt condolence and most profound sympathy on the death of Her Majesty Queen Mary, the senior Honorary Member of this Society.

The Integrity of Her Majesty's long life, Her Devotion and Self-sacrifice at the call of Duty, and Her High-mindedness of Purpose earned Her the deep and abiding Love and Gratitude of all Your Majesty's Subjects. Her shining Example will ever remain as a noble Inspiration to the Nation, Commonwealth and Empire that She loved and served so faithfully and so well.

Given under the Common Seal of the Society at its Apartments in Burlington House this ninth day of April in the year of Our Lord one thousand nine hundred and fifty-three.

L. S.

R. B. Seymour Sewell, *President.*
F. C. Stern, *Treasurer.*
A. Tindell Hopwood, } *Secretaries.*
George Taylor, }

The following were thanked for gifts made to the Library since the last Meeting :—Dr. A. J. Boerman, Mr. W. R. Price and Mr. B. W. Ribbons.

Certificates of recommendation for election to Fellowship were read for the second time in favour of Alan Sydney Fuller, B.Sc., and Dr. James Harry Smith, O.B.E., J.P.

The following were elected Auditors of the Treasurer's Accounts for 1952–53 under Chap. 10, Sect. 7 of the Bye-Laws :—

Representing the Council : Professor F. W. Jane,
Asst. Prof. H. R. Hewer.

Representing the Fellows : Mrs. Vera Higgins,
Dr. C. R. Metcalfe.

The following communications were read and discussed :—

Dr. O. Hedberg. Altitudinal zonation of the vegetation on the East African mountains.

Dr. G. Salt. The Ecology of Kilimanjaro.

Mr. R. Ross. Some aspects of the sub-alpine vegetation on Ruwenzori.

Mr. R. W. J. Keay. Montane vegetation and flora in the British Cameroons.

Prof. A. S. Boughey. The vegetation of the mountains of Biafra.

(In the general discussion the following took part :—the President, Prof. P. W. Richards, Mr. J. W. Purseglove, Mr. R. E. Moreau, Mr. A. W. Exell, Mr. J. B. Gillett, Mr. A. A. Bullock, Mr. E. Milne-Redhead, Miss M. A. Brooke and Dr. George Taylor ; Mr. Ross, Dr. Salt and Dr. Hedberg replied.)

The President announced that the Director, the Keeper of the Herbarium and Staff of the Royal Botanic Gardens, Kew, had invited members of the Society to attend an Exhibition illustrating the activities of the Herbarium and Library during the past hundred years, to be held on 9 May from 9 a.m. to 1.0 p.m.

Those wishing to attend were asked to forward their names to the General Secretary, the Linnean Society, by 23 April.

ALTITUDINAL ZONATION OF THE VEGETATION ON THE EAST AFRICAN MOUNTAINS

By Olov Hedberg.

To students of the fauna and flora of the high East African mountains it is soon apparent that their vegetation varies according to the altitude, presenting a certain zonation. Although the zonation may be rather different on different mountains and also on different sides of the same mountain, depending upon variations in climate and soil, etc., some fundamental similarities exist, which make it possible to recognize the same vegetation belts on all these mountains. A classification of that zonation seems desirable in any biological work concerning their flora and fauna, especially when it involves comparisons between different mountains, and while my own work is mainly concerned with the flora of their highest parts, I have found it advisable to start with a survey of the entire vegetational zonation. The following account is based on relevant literature as well as on my own field studies in seven of the most important mountain districts (Virunga volcanoes, Ruwenzori, Elgon, Aberdare, Mt. Kenya, Kilimanjaro, Mt. Meru). A more detailed account has been published earlier in *Svensk bot. Tidskr.*, **45**, 140–202 (1951).

Before starting to survey the mountain vegetation it is desirable to consider a few theoretical questions. What is a vegetation zone ? What is a vegetation belt ? How should these be delimited ? These questions may of course be answered in various ways. In my opinion, a vegetation zone may be any reasonably well-marked complex of plant communities, confined to a certain level on a particular mountain or in a particular area, e.g. the bamboo zone on Mt. Kenya. It should be delimited only from the vegetation itself and not from climatic or edaphic qualities or historical factors. A vegetation belt is a more generalized concept which it should be possible to recognize on all mountains of sufficient height within a larger part of the world, such as

East Africa. The number and appearance of the zones represented in it on each mountain may vary. The vegetation belts should be so delimited as to reflect the general climatic deterioration towards higher altitude (or latitude) rather than local edaphical conditions. The use of these concepts will be exemplified below.

Three main vegetation belts may be recognized on the high East African mountains (l. c. fig. 4). Above the savanna or scrub of the surrounding plains is first, *the montane forest belt*, characterized by occurrence of tall timber trees, such as *Juniperus procera*, *Podocarpus* spp., and a large number of broad-leaved trees. On Mt. Kenya this belt is differentiated into three rather distinct zones, first a montane rain-forest zone, then a bamboo zone, and finally a *Hagenia-Hypericum* zone, where two of the most important constituents are *Hagenia abyssinica* and *Hypericum lanceolatum*. The last zone is represented also on the Aberdares, but is hardly perceptible on the other mountains. A more or less distinct bamboo zone is also found on most of the Virunga volcanoes, on Ruwenzori, Elgon, Aberdare, and on the south part of Mt. Meru, but not on Kilimanjaro.

Secondly, there is *the ericaceous belt*, mainly dominated by low forest or scrub of *Philippia* and *Erica*, and often containing also much *Stoebe kilimandscharica*, *Adenocarpus mannii*, etc. In its lower part there is often a more or less continuous zone of grassland with only scattered ericaceous trees or shrubs, e.g. on Kilimanjaro, Aberdare, and Elgon. The occurrence of these grassland zones is probably largely to be ascribed to biotic factors, such as fire and grazing. The altitudinal range of this belt varies from a few hundred metres on Mt. Kenya and the Aberdares to more than a thousand metres on Kilimanjaro, and its dominant vegetation shows a wide range of variation from the thick and moist ericaceous forest on Ruwenzori to the dry open scrub on Kilimanjaro—but the flora is largely similar.

Thirdly, above the upper limit of more or less continuous ericaceous (tree- or scrub-) vegetation there is the *alpine belt*. Its appearance is very different on different mountains because of the extreme differences in climate and soil. Whereas on Ruwenzori there occur dense *Senecio* forests and thick *Helichrysum* scrub, Kilimanjaro presents mainly a very open scrub-vegetation of rather desert-like appearance, and at corresponding altitude on Mt. Meru the vegetation is still poorer. Accordingly it has not been possible to find a suitable botanical name for this belt; when the name 'alpine' is used here it is mainly for the lack of a better term and must not be interpreted to mean that this belt is directly corresponding to the 'alpine' belt of Central and North Europe. In fact the climatic conditions at high altitudes near the equator are so vastly different from those of mountains at high latitude that a direct comparison is very difficult. The forest limit, or tree line, which has been used in Europe as lower boundary for the alpine belt, cannot be used with profit in East Africa because of the giant Senecios. Although these must undoubtedly be classified as 'trees' they belong to a very special life-form, apparently adapted to the afro-alpine climate, and on some mountains, e.g. Ruwenzori and Mt. Kenya, they seem to reach the upper limit of phanerogamic plants.

The distribution of various plants and plant communities is governed primarily by two sets of factors, climatic and edaphic. Broadly speaking, climatic factors cause the altitudinal differentiation into vegetation belts, whereas edaphic factors influence the distribution of different plant communities within each belt. But since the dominant communities of different belts have different edaphic preferences, there is sometimes a pronounced inter-digitation at the border between two different belts, especially on such mountains where the sides are dissected by deep valleys and ravines, creating large edaphic diversity within short distance, as on Ruwenzori and the

Virunga volcanoes. In such cases we may get rather a wide border zone between two belts. Further complications are caused by biotic factors such as human influence, notably through fire, lumbering, and cattle grazing, which has sometimes modified the vegetation to a considerable extent even high up the mountains.

The scheme presented here has been found quite helpful for a survey of the high mountain flora. It may perhaps be less satisfactory, e.g. for animal ecologists, because of the large ecological differences between corresponding levels on different mountains, which tend to obscure the fundamental similarities in vegetation zonation.

THE ECOLOGY OF KILIMANJARO

By G. Salt.

Abstract,—

The altitudinal distribution of the vegetation on Kilimanjaro was described, with special reference to the Upper Moorland Zone (11,500–14,000 ft.) and the Alpine Desert (14,000–16,000 ft.). The fauna of these zones was mentioned and some of the special conditions affecting animal life on high tropical mountains were discussed. The paper is published in *J. Ecol.*, **42**, 375–423, 1954.

SOME ASPECTS OF THE VEGETATION OF THE SUB-ALPINE ZONE ON RUWENZORI

By R. Ross.

(With 1 text-figure.)

This contribution is intended to supplement Dr. Hedberg's (1951 and supra) broad picture of East African mountain vegetation by filling in the detail in one small part and thereby giving some idea of the complexity which underlies his wide, and therefore simple, outline. It is confined to Ruwenzori, the only East African mountain that I have visited, and is further restricted to the vegetation lying between the top of the montane rain forest zone and the bottom of the alpine belt, to use Hedberg's terminology. Within those limits, on Ruwenzori, Hedberg recognizes only a bamboo zone and an ericaceous belt.

During the Ruwenzori Expedition, 1952 I had the opportunity of seeing more of the mountain than any previous botanist, whilst my botanical colleague on the expedition, Mr. H. A. Osmaston of the Uganda Forest Department, covered even more ground than I did. The map (fig. 1) shows our routes on the mountain. As a result of these extensive journeys, made within a short period of time, it was possible to form a picture of the vegetation types of the mountain and their distribution on it, much more complete than that obtained from the ascent of a single route combined with the perusal of the accounts of those who have used others.

The lower limit of the area with which I am dealing varies between 2,200 m. and 2,700 m. In general the montane rain forest ascends slightly higher in the valleys than it does on the ridges, and it reaches greater heights to the east and south than it does to the west and north. Thus, in the east it extends up the slopes of the Mobuku valley and the ridges between its tributaries to about 2,700 m. and in the south in the Nyamagasani valley and its flanks to about 2,500 m., whereas in the north the bamboo forest descends to 2,200 m.

on the ridge between the Ruanoli and Lamia valleys, where it almost meets the savannah, and Haumann (1933) gives the same lower limit for the bamboo forest in the west.

The type of vegetation encountered above the upper boundary of the montane rain forest varies according to the nature of the terrain. Four different types of habitat, each with a different type of vegetation, may be distinguished. First of all there are the moderate slopes and rounded ridge

FIG. 1.—Sketch map showing routes of botanical members of Ruwenzori Expedition, 1952.

tops, which are covered by bamboo forest. Very large areas of this bamboo forest, dominated by *Arundinaria alpina* K. Schum. and with little undergrowth other than small herbs, are to be found in the Nyamagasani and Nyamwamba valleys to the south and south-east of the mountain, and also in the Ruanoli and Lamia valleys and on the northern ridge. Here this type of vegetation covers many square miles without interruption. On the ridge between

the Ruanoli and the Lamia it occurs from 3,200 m. down to 2,200 m., but in the south its range is rather less, from about 3,000 m. to about 2,500 m.

In the valleys of the Mobuku and the Bujuku, on the other hand, there is very little bamboo forest. Those who ascend Ruwenzori from Uganda by the normal climber's route up the Mobuku and Bujuku valleys pass through bamboo forest for no more than 400 m. length of path during their ascent. Instead, above the montane rain forest they find steep slopes, mainly of morainic material, at angles of 30°–45°, the second of the four types of habitat mentioned above. These are covered by a type of vegetation for which tangle seems the only appropriate word. It is dominated by *Mimulopsis elliottii* C. B. Clarke, a member of the Acanthaceae, one of a group of plants often encountered in the tropics whose life form is rather difficult to specify. It reaches 3 m. to 4 m. in height but has the habit and form of a herb, with a stem green down to the base but nevertheless up to 3 cm. thick, woody and very tough. With it are associated *Impatiens runssorensis* Warb., which has a very similar habit, *Urtica massaica* Mildbr., a few trees, especially *Vernonia adolfi-fredericki* Muschl., and occasional clumps of *Arundinaria alpina*. This type of vegetation is found from about 2,500 m. to about 3,600 m., although not often above 3,000 m.

In the Lume valley, to the south-west of the mountain, a transitional type of vegetation is found on slopes which seemed to be of intermediate pitch. On these, slightly more open bamboo had a dense undergrowth of *Mimulopsis elliottii* and *Impatiens runssorensis*.

The crests of the ridges, where these have a well-defined crest and not a rounded top, form the third habitat. Here a tree heath, *Philippia johnstonii* Engl., forms narrow strips of woodland between 2,700 m. and 3,200 m. with an undergrowth of short herbs, a quite different vegetation type from the tangle on the slopes themselves. *Rapanea rhododendroides* (Gilg) Mez and, for a short distance above the montane rain forest, *Podocarpus milanjianus* Rendle are also found, but only occasionally. This type of habitat and vegetation was only seen on the east side of the mountain. To the north and south, where the ridge crests are more rounded, bamboo forest normally runs right across them, although occasional clumps of *Philippia johnstonii* occur.

Another tree heath, *Erica bequaertii* de Wild., dominates the fourth habitat at this level, the boggy flats found usually at the bottoms of the valleys but at times on flat portions of the ridge crests. On these boggy flats the *Erica* is normally the only tree species present. Below it various herbs and ferns, including a semi-woody species of *Alchemilla*, are normally found. This type of heath forest occurs between 2,750 m. and 3,200 m. in the Mobuku and Ruanoli valleys. Boggy flats were not seen at this level elsewhere on the mountain, nor are there any descriptions of them in the literature.

It is necessary now to consider the vegetation at slightly higher levels than those discussed so far. On some of the other mountains of East Africa a zone dominated by *Hagenia abyssinica* (Bruce) Gmel. and species of *Hypericum* is reported as occurring above the bamboo zone (Hedberg, 1951), but this is not recorded for Ruwenzori. To the north, the east and the south of the mountain, however, at heights between 3,000 m. and 3,300 m., there are in the valleys quite extensive areas of forest dominated by *Rapanea rhododendroides*, associated with which are considerable numbers of *Hagenia abyssinica* and occasional *Hypericum keniense* Schweinf. *Vernonia adolfi-fredericki*, *Lobelia gibberoa* Hemsl. and, towards its upper limit, *Senecio erici-rosenii* R.E. & Th. Fries, are frequent in this forest, which has a field layer very rich in species and seems to correspond to some degree to the *Hagenia-Hypericum* zone of the other mountains. This type of vegetation is not recorded from the west of the mountain where, according to Haumann (1933), bamboo

forest passes straight into heath forest. Haumann's route, however, was up a ridge, and Osmaston informs me (*in litt.*) that he thinks it likely that *Rapanea-Hagenia* forest also occurs on that side of the mountain.

It is of interest to note that the heath forest found on the ridges to the south and west of the mountain between 2,800 m. and 3,300 m. is dominated by *Erica bequaertii* associated in the west with *Erica arborea* L. (Haumann, 1933), and that it has an undergrowth very different from and much richer than that of the heath forest dominated by *Philippia longifolia* Engl. which occurs from 3,300 m. upwards all around the mountain. In this *Erica* forest *Rapanea rhododendroides* is fairly common, to the south at least, and *Hagenia abyssinica* is reported in some numbers from the west. Both Haumann (1933), describing the west slopes, and Synge (1937), describing the south, draw attention to this division in the heath forest at about 3,300 m. It is possible that this *Ericetum*, as distinct from *Philippietum*, should be regarded as forming, along with the *Rapaneetum* described just above, a zone corresponding to the *Hagenia-Hypericum* zone of the Virunga volcanoes, Mt. Kenya and the Aberdares.

Above about 3,300 m., and usually up to about 3,800 m. or, in places, 4,000 m., the mountain, with the exception of the boggy flats, which may be quite extensive, is covered by a heath forest dominated by *Philippia longifolia*. In the east and north, and apparently in the south also, *Philippia longifolia* is almost the only tree, an occasional arborescent *Senecio* being its sole associate. In the west, however, *Philippia lebrunii* Staner is mixed with the *Philippia longifolia* (Haumann, 1933). This forest is the heath forest proper of Ruwenzori, of which all travellers on the mountain speak in such horrifying terms, a maze of twisted and gnarled trunks and branches draped with *Usnea* and rising from a deep carpet of moss spreading over the ground and a tangle of fallen trunks, through the concealed gaps in which you can disappear to the waist, or even further. Although elsewhere well developed, this heath forest is only patchy in the Ruanoli valley, where, judging from conditions in late July and early August 1952, the climate may be rather less humid than elsewhere on the mountain at this altitude. Here *Senecio* forest descends lower than usual and almost meets the particularly well-developed *Rapanea-Hagenia* forest of this area.

Although the boggy flats below the level of the heath forest proper are covered by a vegetation dominated by tree heaths, above 3,300 m. they are covered by sedge bogs with many *Lobelia bequaertii* de Wild. and arborescent *Senecio*, vegetation quite closely resembling in general facies, although many species are different, that found on the slopes of the mountains above the Ericaceous belt. The normal dominant of these bogs is *Carex runssoroensis* K. Schum., not only within the Ericaceous belt but also well up into the alpine zone. However, the bog in the Mobuku valley just below the Kawamba rock shelter at about 3,300 m. has no *Carex runssoroensis* on it but is dominated by other species of sedge. This is of particular interest, since the large Bigo bog in the Bujuku valley just to the north and at the same altitude is dominated by *Carex runssoroensis*.

From this account it will be clear that, although altitude is probably the most important of the factors controlling the vegetation of Ruwenzori, the influence of others is strong enough to produce a complicated pattern of communities at any level, and even this account presents a simplified and schematized picture. At its conclusion, I must acknowledge my great indebtedness to Mr. H. A. Osmaston for the help I received from him in the field and for his criticisms of the manuscript. It was his experience of, and insight into, the vegetation of the mountain which enabled me to understand something of what I saw.

References.

Haumann, L. 1933. Esquisse de la végétation des hautes altitudes sur la Ruwenzori. (Troisième communication.) *Bull. Acad. roy. Belg.* (5), **19,** 900–917.
Hedberg, O. 1951. Vegetation Belts of the East African Mountains. *Svensk bot. Tidskr.*, **45,** 140–202, pls. i-vi.
Synge, P. M. 1937. *The Mountains of the Moon.* London.

MONTANE VEGETATION AND FLORA IN THE BRITISH CAMEROONS

By R. W. J. Keay, M.A., F.L.S.

(With 1 text-figure.)

The montane flora of the Cameroons is, perhaps, rather a 'poor relation' of the montane floras of eastern Africa, but it is interesting and important because of its very existence and for historical reasons.

Ninety years ago (5 November 1863) Sir Joseph Hooker addressed this society "On the plants of the Temperate Regions of the Cameroons Mountains and Islands in the Bight of Benin; collected by Mr. Gustav Mann (1864)". Mann, in December 1861, was the first European to climb Mt. Cameroon. His collection from the mountain, above the forest, was remarkably complete, except for the grasses. Many other botanists have collected there, including the Germans, Preuss, Deistel and Mildbraed, and among British botanists, Maitland, Migeod and, in recent years, P. W. Richards and J. P. M. Brenan of the 1948 Cambridge Botanical Expedition. The flora of the zones above the forest on Mt. Cameroon is therefore comparatively well known.

The intention of this paper is, however, to draw attention to the extensive mountain areas in the hinterland of the Cameroons which are far less thoroughly known than the classic Cameroon Mountain itself. Ledermann (1908–9) collected many specimens, most of which were, unfortunately, destroyed with the Berlin herbarium; Maitland and A. T. Johnstone collected in Bamenda and more recently I and my colleagues have collected on the Sonkwala mountains in Nigeria and in Bamenda Province. The map (fig. 1) shows the main vegetation regions of the Cameroons, including the montane areas (above 5,000 ft., 1,525 m.). The main massifs are Mt. Cameroon (13,350 ft., 4,072 m.), Kupe (6,791 ft., 2,071 m.), Manenguba (7,382 ft., 2,251 m.), Bamenda (8,000 ft., 2,440 m.), and Sonkwala (6,300 ft., 1,922 m.).

Geography.

(1) *Mt. Cameroon* is an active volcano, 13,350 ft. (4,072 m.) high, which last erupted in 1922. Debundscha, on the coast immediately S.W. of the mountain, is one of the wettest places in the world, having a mean annual rainfall of about 375 in. (9,525 mm.). Buea, at an altitude of about 3,000 ft. (915 m.) on the eastern side of the mountain, has a mean annual rainfall of 114 in. (2,895 mm.), and the forest above Buea is enveloped in cloud for much of the year. The upper slopes of the mountain, above about 7,000 ft. (2,135 m.) are drier and colder and are swept for much of the year by the N.E. trade winds which are biting cold at the summit where snow has been known to fall. Porous volcanic lava is everywhere abundant. The lack of ground water limits camping to two main sites, Mann's Spring (7,400 ft., 2,257 m.), and Hut No. 2, known to the Germans as Johann-Albrechtshöhe (9,120 ft., 2,850 m.).

(2) *Mountains of the hinterland.* These are separated from Mt. Cameroon by extensive tracts of lowland rain forest, the nearest (Mt. Kupe) being 50 miles away. In most of these mountain-massifs there is some trace of the 'African

Surface', the Miocene peneplain which is today at an altitude of 4 000-5,000 ft. and is extensive in eastern Africa but very poorly represented in West Africa. The highest mountains in these inland ranges are just above 8,000 ft. alt. Many of them are of volcanic origin (Tertiary) but they are no longer active and have nothing comparable to the bleak slopes of porous lava which are so characteristic of Mt. Cameroon. Many of the volcanic craters are today beautiful lakes surrounded by steep forest-clad sides. In some of these crater-lakes a gaseous discharge occasionally poisons the water and produces a miraculous draught of fishes, much to the delight of the native population. These inland mountains have many permanent streams, as well as lakes, and the country is altogether better watered at the higher altitudes than is Mt. Cameroon—much to the benefit of the flora.

PROVISIONAL MAP OF VEGETATION REGIONS

FIG. 1.

VEGETATION.

The montane communities seem to occur in a definite altitudinal sequence, but factors other than altitude are usually of prime importance in determining the point at which one type gives way to another in any one locality. The

factors to be considered include slope, aspect, moisture-retentive capacity of the soil, and fires. Fire is normally regarded as a biotic factor, but on an active volcano periodic fires are a natural occurrence. Fires, both natural and man-made, and the extremely porous lava soil are perhaps the outstanding ecological peculiarities of Mt. Cameroon.

The main types of vegetation in order of ascending altitude appear to be :—

(1) *Montane Forest.* The evergreen forest up to 5,000 to 6,000 ft. (1,525 to 1,830 m.) altitude is enveloped in cloud for long periods and has a profusion of mosses and of various epiphytes, such as orchids, and species of *Begonia, Peperomia* and *Impatiens.* The tree canopy is often irregular and broken and includes such species as *Polyscias ferruginea, Schefflera hookeriana* and *Conopharyngia* spp. The tree fern *Cyathea manniana* is locally very abundant in more open places.

Above about 6,000 ft. the forest is definitely drier and more stunted and the trees are bearded with masses of lichen ; tree-ferns are rare. *Syzygium staudtii, Schefflera mannii, Lachnopylis mannii, Pittosporum mannii, Agauria salicifolia, Bersama* spp., *Clausena inaequalis* and *Rapanea neurophylla,* are characteristic species of this upper forest. Clumps of the tall shrubby Acanthaceous plant *Mimulopsis violacea* and of large balsams (e.g. *Impatiens sakeriana*) occur.

The upper limit of evergreen montane forest varies from 6,000 to nearly 8,000 ft.

(2) *Montane Woodland.* This is a drier type often with abundant grass which always occurs on the edge of montane forest but in parts of Bamenda forms extensive stands. The typical trees are *Lasiosiphon glaucus, Hypericum lanceolatum, Philippia mannii, Agauria salicifolia* var. *pyrifolia, Adenocarpus mannii, Myrica arborea,* the tree-fern *Cyathea dregei* and the shrub *Nepeta robusta.* European genera are well represented among the herbs by such plants as *Geranium simense* and *G. ocellatum, Viola abyssinica, Galium simense, Thalictrum rhynchocarpum, Delphinum dasycaulon, Rumex abyssinicus* and *R. bequaertii.* This woodland is easily degraded by fire to a savannah type with widely spaced trees and tall tussocky grasses. In those parts of Bamenda where this woodland is well developed there is usually some form of natural protection from fire.

On the fire-swept porous lava slopes of Mt. Cameroon the woodland is very poorly developed, being confined to the forest edges and partially protected gullies. Instead there are vast expanses of grassland, dominated by such savannah genera as *Andropogon* and *Loudetia,* 0·5–1 m. high, while the trees (*Lasiosiphon, Agauria, Hypericum,* etc.) are confined to gullies. The European genera do not seem to be able to cope in the savannah.

(3) *Bamboo brakes.* Pure stands of *Arundinaria alpina* occur in parts of Bamenda above about 7,000 ft. (2,135 m.) altitude, but are unknown on Mt. Cameroon. *Sanicula europea, Thalictrum rhynchocarpum* and other European genera favour this community.

(4) *Montane short-grassland.* Above about 7,800 ft. (2,379 m.) in Bamenda and about 10,000 ft. (3,050 m.) on Mt. Cameroon the savannah-like derivatives of montane woodland are replaced by communities of more compact, shorter grasses often with narrow, rolled leaves, and usually with plenty of moss between the tussocks. Trees are absent, though the shrubby *Adenocarpus mannii* goes up to about 10,700 ft. alt. Plants of European affinity become abundant in this type of grassland—e.g. *Festuca, Deschampsia, Koeleria, Sagina, Silene, Cerastium.* The heath *Blaeria mannii* and species of *Helichrysum* are very characteristic.

At and near the summit of Mt. Cameroon, the loose cinder-like lava is sparsely covered by moss, lichens and short tufts of the grass *Pentaschistis mannii.* A few herbs are present including *Crepis cameroonica, Blaeria mannii* and *Helichrysum mannii,* but no plant exceeds 15 cm. high.

The Flora.

Sir Joseph Hooker in 1863 mentioned six outstanding features of the montane flora of Mt. Cameroon and the neighbouring islands, and it is of interest to review his observations in the light of the botanical exploration and research since Mann's remarkable collections were first reported to this Society. The features considered outstanding by Hooker were :—

(1) The poverty of the flora.
(2) The preponderance of Abyssinian genera and species.
(3) The considerable proportion of European plants.
(4) The paucity of South African genera and species.
(5) The great rarity of new genera.
(6) The absence of St. Helena types.

By and large these remarks still hold good today. As regards the Abyssinian or east African genera, there has been a tendency to regard the plants of the Cameroons as a distinct species, but more recent work has shown that many of these are best regarded as conspecific with the east African types—e.g. *Thalictrum rhynchocarpum* Dill. & Rich. (syn. *T. mannii* Hutch.), *Clematis simensis* Fresen. (syn. *C. altissima* Hutch.), *Crassula alba* Forsk. (syn. *C. mannii* Hook. f.).

Amongst the plants of European affinity, however, the modern tendency has been to regard the African plants as distinct species, albeit closely related to their European congeners—e.g. *Cerastium octandrum* Hochst. ex A. Rich. (distinct from *C. vulgatum* L.), *Umbilicus botryoides* Hochst. ex A. Rich. (distinct from *U. pendulinus* DC.), *Succisa trichotocephala* Baksay (distinct from *Succisa pratensis* Moench). A number of such plants have, however, still withstood the efforts of critical botanists to split them—e.g. *Radiola linoides* Roth and *Cardamine hirsuta* L.

The more recently explored mountains of the hinterland have a much greater range of favourable habitats in the 6,000–8,000 ft. (1,830–2 440 m.) altitudinal zone than has Mt. Cameroon and consequently the flora is richer, chiefly owing to the addition of many genera and species of East and South African affinity. Among the montane species known from the mountains of the hinterland, but not from Mt. Cameroon, may be mentioned :—

Cyathea dregei (also at 5,400 ft. in grassland on Bintumane Peak, S.L.)
Podocarpus milanjianus
Delphinium dasycaulon
Clematopsis scabiosifolia (a species of the ' African surface ' rather than montane)
Xymalos monospora (also on Fernando Po)
Harpagocarpus snowdenii
Protea sp.
Dissotis spp many in Bamenda ; virtually absent on Mt. Cameroon)
Lotus discolor
Albizia gummifera
Rhamnus prinoides
Dipsacus pinnatifidus
Crepis newii (subsp. *kundensis*)
Carex cuprea
Arundinaria alpina

It is not the intention of this paper to discuss why the flora has such striking affinities with the mountains of eastern Africa and with Europe, but it must be emphasized that any theory proposed has to explain why a rather similar flora is also found on the islands of the Gulf of Guinea (Fernando Po, Principe, S. Tomé and Annobon) and on the Fouta Djalon massif, the source of the River Niger.

Reference.

Mann, G. 1864. *J. Linn. Soc.* (*Bot.*), **7**, 171–240.

THE VEGETATION OF THE MOUNTAINS OF BIAFRA

By A. S. Boughey.

(With 1 text-figure.)

During the past two years several small expeditions from my department in the Gold Coast have visited the three highest mountain masses of West Africa, Clarence Peak on Fernando Po, Cameroons Mountain and the Bamenda Highlands, all of which are closely grouped about the Bight of Biafra.

The immediate object of these expeditions was to obtain material for comparative systematic studies on the Flowering Plants and Ferns of our area, to obtain more detailed information on the altitudinal zonation of the mountain vegetation and to make preliminary ecological observations. The collections made by Mr. C. D. Adams, Mr. J. K. Morton, Mr. G. K. Akpabla and myself number over 3,000, and these have not yet been fully examined and identified. It is intended eventually to publish detailed systematic lists based on these collections, but already a number of points have appeared from these studies which I propose to outline this evening.

In any critical examination of the altitudinal zonation of the vegetation of the West African Mountains, the Cameroons Mountain is the obvious starting point. It is 4,000 ft. higher than any of the others, and on its western or sea-ward side its slopes rise virtually directly from sea level. It is readily accessible, so that in the 92 years since it was first ascended by Europeans it has been visited frequently by British and German botanists. The flora of the Mountain is therefore comparatively well known, and the altitudinal distribution of the species is correspondingly well recorded. I thought it might prove instructive if these existing records of the vertical distribution of species were analysed to determine whether any *critical levels* could be recognized, that is, levels beyond which many species do not extend but are replaced by other species. The results of this analysis are shown in the table below. A more accurate analysis will be possible when our own collections have been fully worked out, and it should also be possible to examine our records from the other two areas in the same way.

It appears that critical levels occur on the Cameroons Mountain at intervals of approximately 2,000 ft. Using the factor of a decrease of 0·6° C. for every 100 m. rise which Lebrun (1935) gives for Ruwenzori, the temperature equivalent of these intervals is about 7° F. That is, with a noon shade temperature of 90° F. at sea level, that on the summit would be about 41° F., which indeed it often is. Unlike a number of the E. African mountains, it is not therefore usual for snow to persist on the summit of Cameroons Mountain, although several observers record having seen it there from a distance. As will appear later, the altitudinal zonation cannot however be simply explained on this temperature factor alone.

While the majority of species are restricted to a single zone, not a few extend into a second. A small number of species have an even greater range. *Desmodium repandum* and *Crassocephalum mannii*, for example, extend from 2,000 ft. to over 8,000 ft., the whole extent of the upland forest in fact. *Lactuca capensis*, a grassland species, occurs throughout the grassland above the forest limits, from about 8,000 ft. to the summit at 13,350 ft.

Two of the zones, the first and third lowest, are essentially covered by forest, the two highest are substantially grassland. The second and fourth may bear a forest or a grassland type of vegetation.

It was thought desirable, for greater convenience, to give a series of names to these zones, even although some of the names might have to be rather arbitrary. The first zone, the lowland Tropical Rain Forest, was not considered further in these studies : it is not in fact adequately represented in the table.

The vegetation of the next zone is clearly related to the Lowland Rain Forest. It has several trees belonging to the Flacourtiaceae, many shrubs in the Rubiaceae, and a fair representation of species in the families Acanthaceae, Commelinaceae, Euphorbiaceae and Zingiberaceae, although these species are in general not the same ones as those occurring below 2,500 ft. This zone from 2,500 ft. to 4,500 ft. was accordingly called the *Mountain Rain Forest* zone, a name which has already been used by Exell (1944) in respect of similar vegetation at this altitude on the island of S. Tomé.

The majority of species in the next zone extend into it from the adjacent zones. There are however some species, especially Orchids and Begonias, which are confined to it. Because between 4,500 ft. and 6,000 ft. there is so often cloud down to ground level, the term *Mist Forest*, which has been used previously for this zone (Exell, 1944; Keay, 1949), was considered satisfactory.

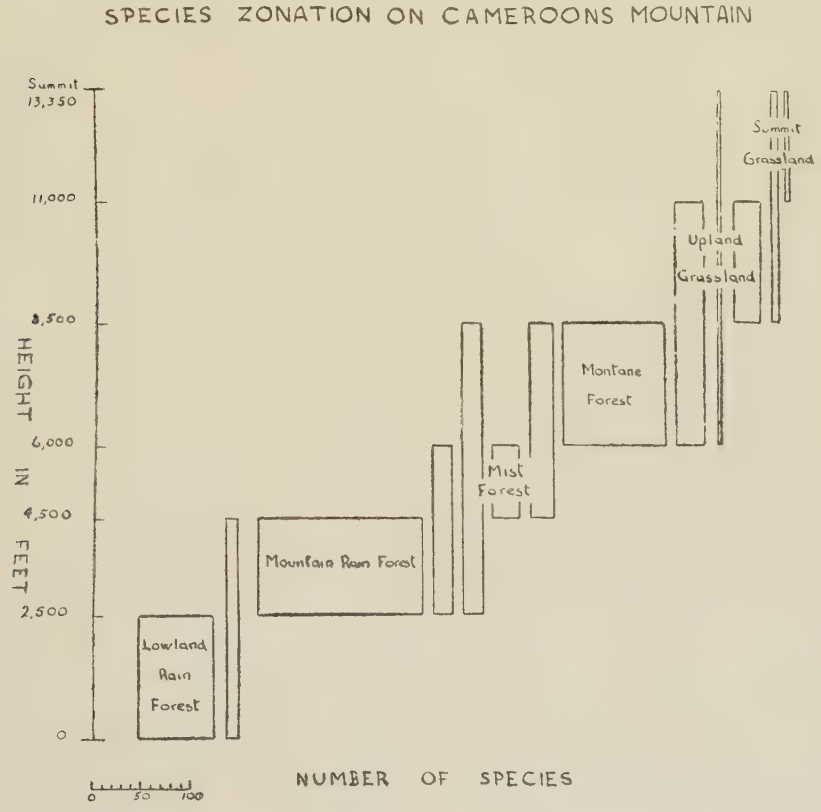

FIG. 1.

Above the Mist Forest the forest vegetation from 6,000 ft. to 8,500 ft. has been termed *Montane Forest*, as it appears to correspond to the Montane Forest of the E. African mountains (Hedberg, 1951). The greater part of this zone on Cameroons Mountain is however occupied by grassland. The term *Upland Grassland* cannot therefore be restricted entirely to that lying between 8,500 ft. and 11,000 ft., but is conveniently broadened to include such grassland as occurs in the Montane Forest zone.

Many of the Upland Grassland species are not found over 11,000 ft. and it seems reasonable to give the name *Summit Grassland* to the zone between

this height and the summit. A few plants such as *Anthospermum camerooneuse* and *Pentaschistis mannii* have been recorded only from this last zone, which corresponds in position, but not in its vegetation, to the Alpine belt of the E. African mountains.

These six altitudinal zones on the Cameroons Mountain have been defined in the first instance solely on floristic grounds, but in the naming of them it seems impossible to eliminate ecological considerations. It was interesting during our visits to the mountain to see whether this theoretical and composite classification of the mountain vegetation coincided with any features which could be observed in the field, and whether the same zonation could be applied in Fernando Po and the Bamenda Highlands.

The Mountain Rain Forest zone has been much disturbed on the Cameroons Mountain. On the eastern, or Buea side, the forest has been cleared up to a height of 3,500 ft. for agricultural crops or pasture. On the sea-ward side, which I did not see, it may not have been quite so much destroyed. Above this clearing, to about 4,300 ft. on the southern and to 5,500 ft. on the eastern slopes of the mountain, there are extensive coco-yam farms, above these heights the natives say the coco-yam grows too slowly to be worth while. Up to this altitude it is difficult to decide on the nature of the original vegetation of this zone. About the level of the highest farms there is however a characteristic belt where a species of *Macaranga* becomes very abundant in the single tree layer. Above this again, and at about the upward limit of the zone, is a belt where the clumps of the tree fern *Cyathea manniana* become both more frequent and more extensive. The Mountain Rain Forest, although it may well be a single floristic unit, appears therefore to be subdivided into several ecological types.

The Mist Forest, on the other hand, is remarkably uniform, not only floristically but ecologically. It has typically one or two tree layers, in which the genus *Schefflera* is prominent, and a dense shrub layer. The poverty of species is apparent in the dearth of flowering material to be collected in this zone. It is however very rich in epiphytes, presumably because of the constant high humidity maintained by the low cloud so often shrouding this zone. Orchid, *Begonia* and *Peperomia* species are an important element of this epiphytic flora. Towards the upper limit of the Mist Forest, at about 5,500 ft., the shrub layer tends to open out, occasional patches of bracken appear in open places, and herbaceous plants such as *Viola abyssinica*, *Thalictrum mannii*, *Galium spurium*, *Cryptotaenia africana* and *Stellaria mannii* are to be found.

On the south-east side of the mountain, above Buea, the forest in some places ends abruptly a hundred feet or so above this level. In a number of places on the western side, near Mann's Spring, it continues upwards for a further 2,000 ft. Wherever it ends, the forest is edged by a narrow sub-zone some 30 yards or so deep, which I have called the *Ericaceous sub-zone* because of the conspicuous presence in it of *Philippia mannii*, *Agauria salicifolia*, *Hypericum lanceolatum* and *Adenocarpus mannii*. In this Ericaceous sub-zone there is, nearest the woodland, a close stand of trees, principally *Agauria* and *Lasiosiphon glauca*, bordered by a tall shrubby growth of *Hypericum* and *Philippia*, with beyond this a more open stand of *Nepeta robusta* and *Adenocarpus*. Amongst these shrubs are numerous plants of other species, particularly of Compositae and Labiatae. This narrow strip of vegetation is indeed floristically one of the richest of the whole mountain. While it occurs as a forest fringe at varying altitudes between about 6,000 ft. and 9,000 ft., according to the upward limits of the forest, isolated patches of this Ericaceous scrub may also be found throughout the Upland Grassland to about 9,500 ft. in gullies and old craters. Two extensive areas of it grow on the very precipitous slopes of the two great ravines cut in the face of the 2,000 ft. ridge opposite

Buea. Isolated plants of this scrub, especially of *Agauria*, *Hypericum*, and *Adenocarpus*, may be found up to 11,000 ft., posing some interesting ecological problems.

On all sides of the mountain, but more particularly near Mann's Spring, tongues of forest reach up from 6,000 ft. to 8,500 ft., or a little over. The highest forest I have seen myself was at 8,700 ft. This Montane forest is quite distinct in its flora and of a characteristic structure. There is typically a single tree layer, no shrubby layer and few lianes or epiphytes. The herbaceous ground flora is rich and there are frequently patches of grass, which are grazed by antelopes whose paths criss-cross this forest. The trees are mostly *Agauria*, *Maesa lanceolatum*, *Pittosporum mannii* and *Hypericum*, and they are commonly covered by a dense growth of lichen. The ground flora is composed mainly of species of the temperate herbaceous families Caryophyllaceae, Umbelliferae, Compositae and Labiatae. Species of *Rubus* and *Carex* also characteristically occur here.

In the next zone, the Upland Grassland, the conditions suddenly become much drier, and the rainfall of this part of the mountain must be much lower than further down. The cycle of lava flow colonization here seems to take much longer than in the forest. The lava flow, which in the 1922 eruption ran down to the sea, is already at its base showing some tree growth. The open lava flow up which Burton and Mann made their way from 4,500 ft. in 1861 is now unrecognizable in the general forest growth. By contrast the lava flows of the Upland Grassland, which cover an increasing proportion of the ground as one ascends, are but sparsely covered with grass and a few flowering plants and ferns, and above 10,000 ft. or 11,000 ft. they are for the main part either bare or covered in a dusty grey growth of lichens and mosses.

The grass is tinder dry by December, and it is deliberately fired annually at this time by local hunters who are interested in obtaining antelope meat and honey. While there is no obvious zonation in the Flowering Plants at this altitude, the principal grasses show a marked zoning, which was first described by Maitland (1932). Many of the species in both this and the Summit Grassland appear to be pioneer plants in lava flow colonization, and the vegetation at these heights is perhaps best regarded as a complex of various seral stages of lava flow colonization.

It seems more likely that volcanic disturbances, rather than adverse climatic conditions, are responsible for the scanty plant cover on these upper slopes of the mountain. The absence of any vegetation comparable with that of the Alpine Zone of the East African Mountains may be due partly to the continued periodic volcanic activity. A further explanation may lie in the rather lower height of the Cameroons Mountain compared with the mountains of East Africa. It is at least 1,000 ft. lower than the smallest with a well-developed Alpine zone, and 6,000 ft. less than the highest. This additional height would be of vital importance during the warm periods which are known to have occurred during Pleistocene times, when it is to be assumed that the whole mountain zonation, which is basically, although by no means entirely, determined by temperature, would move further up. In the case of the Cameroons Mountain, which may well have had some sort of alpine vegetation at its summit, the mountain would literally have become too hot to hold it. With the return of cooler conditions, unless they were so cool as to permit the migration of alpine species across the breadth of Africa, there would be no opportunity for recolonization of the now once more suitable habitat by such species.

Turning now to Fernando Po, whose highest point at 9,350 ft. is about 50 miles from the summit of Cameroons Mountain, conditions very similar to those described for the Cameroons Mountain are to be found. Although a

shallow strait some twenty miles broad now separates the island from the African mainland, it seems likely that, at any rate when the temperate element of its flora was established, Fernando Po had a land-connection with the mainland. The whole island is volcanic in origin, but unlike the Cameroons Mountain there is no historical record of any recent violent volcanic activity. Because of this, and perhaps also because the rainfall is more evenly spaced throughout the year, there are no bare or sparsely colonized lava flows, and the island has a more mature appearance.

The Lowland Rain Forest has been virtually destroyed during the clearing operations for the establishment of coffee and cocoa plantations. Apart from this, and with the exception of the Moka plateau in the south of the island, the vegetation has not been interfered with as it has on the Cameroons Mountain. The Mountain Rain Forest has a tree fern sub-zone at its upper limit, with a *Macaranga* sub-zone immediately below. Lower down than this, at the height at which the forest has been cleared on the Cameroons Mountain, is a sub-zone in which the shrub layer is high and open and there is a fairly dense ground layer composed largely of terrestrial ferns.

The Mist Forest appears to go up a further 1,000 ft. on Fernando Po, and to contain a larger proportion of *Schefflera* species. It is still however very poor in phanerogamic species and characterized by a dearth of plants in flower, apart from the epiphytic Begonias and Orchids, which are here perhaps a little more numerous.

The change from Mist Forest to Montane Forest is indicated by the appearance of open bracken-filled glades often lined by a shrubby growth of *Hypericum lanceolatum* and *Crassocephalum mannii*. From 8,000 ft. to about 9,000 ft. on Clarence Peak, there is the same Montane Forest as on Cameroons Mountain, except that it is better developed and in a continuous level belt instead of a series of tongues. Plants such as *Pycnostachys meyeri* and one, or possibly two, species of *Carex*, which only occur on the Cameroons Mountain in a limited number of localities in this Montane Forest, are widespread right through it on Clarence Park.

For about the last 500 ft. on the Peak itself, and isolated on the very summits of three adjacent subsidiary peaks, Upland Grassland replaces the Montane Forest. On the edge of the forest, and separating it from the grassland, as on the Cameroons Mountain, is a narrow Ericaceous sub-zone, with again such species as *Hypericum lanceolatum, Lasiosiphon, Maesa lanceolatum, Pentas occidentalis, Pittosporum mannii* and a second *Pittosporum* species. The Upland Grassland appears to be more tussocky and taller than on Cameroons Mountain, but this may be due to the fact that it is burnt less frequently. Mann (1862) states that it had been burnt before his visit in 1860, but when I was on the summit in January 1953, the driest month of the year, it had not been burnt and it was far too wet to burn. The same common species of phanerogams such as *Cyanotis mannii* and *Trifolium simense* are to be seen, but a number of the species such as *Anthospermum cameroonense* and *Pentaschistis mannii*, recorded as confined to the Summit Grassland of Cameroons Mountain, have not yet been found on Clarence Peak.

The limits of the Montane Forest, the Upland Grassland and the intervening sub-zone of Ericaceous scrub appear to fall within a much closer range on Clarence Peak, perhaps because it has not been periodically devastated by volcanic activity as has the summit of Cameroons Mountain. Fernando Po is not, however, without one outstanding anomalous feature, the grassland of the Moka plateau between 4,000 ft. and 5,000 ft. Plants such as *Lobelia columnaris, Sebaea multinodis, Geranium simense* and *Viola abyssinica*, which otherwise only occur at about 9,000 ft. on Clarence Peak, are to be found in the grasslands of this part of the island down to 4,000 ft.

The origin of the grassland is obscure. The area was certainly greatly extended by forest clearing some seventy years ago, but it seems possible that the native inhabitants of the island had established a limited area of grass there previous to this. The grassland is quite different from that to be found at the same height in the Bamenda Highlands, presumably because of the very different rainfall, but it is possible that if the Mist Forest of the Cameroons Mountain were to be cleared, a similar grassland would be established.

The Bamenda Highlands are a much older and a much more extensive mountain mass than either Cameroons Mountain or Fernando Po. There is no evidence there of recent volcanic activity and the Highlands are not primarily volcanic in origin. They consist essentially of a number of high valleys lying approximately between 4,000 ft. and 5,000 ft., separated by mountain ridges some 6,000 ft. high. These ridges broaden in places to form extensive plateaux with still higher peaks. There are four or five such peaks reaching between 8,000 ft. and 9,000 ft. The nearest of these high peaks is some 100 miles inland from Cameroons Mountain.

The Highlands therefore lie approximately within the two altitudinal zones which have here been called Mist Forest and Montane Forest, but there are two very important differences between this and the two previous areas. The rainfall is much lower and the dry season longer, and the valleys are densely settled by pagan agriculturalists and Fulani pastoralists. The former cultivate all the land in the valleys, and the Fulani herds graze the valley slopes to their summits. Whether this farming and grazing, together with a deliberate policy of annual grass firing, has been the primary cause of, or has assisted in the process of the destruction of, a pre-existing forest, is a question which it is now difficult to settle; at all events there is little forest to be found in the Highlands at the present time. In the valleys the only woody vegetation preserved is around the *Raphia* swamps; on the slopes it is confined to the sides of the gullies and streams. Only around the base of the highest peaks on the upland plateaux are there extensive tracts of woodland.

I have climbed only the one such peak which is nearest to the town of Bamenda, and which rises from a plateau at about 6,000 ft. to a height of about 8,500 ft. On one side of this peak there is woodland right to the summit, so that the tree limit, dictated here by topography, appears to be at much the same level as in Fernando Po and the Cameroons Mountain. The woodland appears to be very similar in both structure and composition to the Montane Forest of those areas, and it is edged by a similar Ericaceous sub-zone.

This Ericaceous sub-zone, as in the Cameroons Mountain, is also found lower down to about 6,000 ft., where it frequently fringes the sides of the perennial streams. It is much richer in species here than in the other two areas, containing for example a second shrubby *Hypericum* species, *H. riparium* in addition to *H. lanceolatum*, *Osmunda regalis*, a southern African tree-fern *Cyathea dregei*, and many other interesting additional species especially in the families Compositae, Melastomataceae and Crassulaceae.

Below 6,000 ft. the flora is a mixture of three different elements, containing species from the Mist Forest, Lowland Guinea Savannah and what might be called Upland Savannah. There are a number of Lowland Savannah trees such as the Shea Butter and species of *Cussonia*, *Annona* and *Entada*, with a number of Guinea Savannah grasses. Many of the so-called Upland Savannah species occur also on the Bauchi Plateau.

While the Cameroons Mountain and Fernando Po, being sparsely populated at the higher altitudes, and so little disturbed by human influences, seem the most promising areas for further ecological studies, it is the Bamenda Highlands which will most interest the systematic botanist, and which will provide the best evidence of the relationship between the mountains of the West and

of the East of Africa, and of the high mountains of the West with the drier western Upland Plateaux.

References.

Exell, A. W. 1944. *Catalogue of the Vascular Plants of S. Tomé.* London.

Hedberg, O. 1951. Vegetation Belts of the East African Mountains. *Svensk. bot. Tidskr.*, **45**, 140–202.

Keay, R. W. J. 1949. *An outline of Nigerian Vegetation.* Lagos.

Lebrun, J. 1935. Les essences forestières des régions montagneuses du Congo oriental. *Publ. Inst. Agron. Congo Belge.* (sci.), **1**.

Maitland, T. D. 1932. The Grassland Vegetation of the Cameroons Mountain. *Kew Bull.*, **9**, 417–425.

Mann, G. 1862. Account of the Ascent of Clarence Peak, Fernando Po, altitude 10,700 ft. *J. Linn. Soc.* (*Bot.*), **6**, 27–30.

PROCEEDINGS OF THE GENERAL MEETING HELD ON 7 MAY 1953

Lt.-Col. R. B. Seymour Sewell, C.I.E., F.R.S., President, in the Chair.

The Proceedings of the General Meeting held on 23 April 1953, having been circulated, were taken as read, and confirmed.

The President read a letter from the Home Secretary in reply to the Message of Sympathy sent to Her Majesty The Queen on the death of Her Majesty Queen Mary.

The President also read a letter from Fellows on the Staff of the Royal Botanic Gardens, Kew, expressing their great regret at being unable to be present at the Meeting.

The following were thanked for gifts made to the Library since the last Meeting :—Mr. K. Cherian Jacob, Professor J. Omer-Cooper, Mr. H. Stansfield, Mr. B. Verdcourt and Messrs. Chapman & Hall, Ltd.

The following signed the Obligation in the Roll and Charter Book, and were admitted Fellows :—George Henry Preston, Robert Desmond Meikle, B.A., LL.B., Leslie Gordon Glynn Warne, M.Sc., Ph.D., Abraham Fahn, M.Sc., Ph.D., John Francis Michael Cannon, B.Sc. and Alan Sydney Fuller, B.Sc.

Certificates of recommendation for election to Fellowship and Foreign Membership were read for the second time in favour of those named in the Proceedings of the General Meeting held on 23 April 1953.

The following communications to commemorate the bicentenary of the publication of the *Species Plantarum* were read and discussed :—

Dr. T. A. Sprague, F.L.S. The Plan of the *Species Plantarum.*

Mr. John L. Gilmour, F.L.S. Linnaeus's *Species Plantarum*; the man and the book.

Mr. W. T. Stearn, F.L.S. The *Species Plantarum* and the Language of Botany.

Dr. J. Ramsbottom, O.B.E., F.L.S. Linnaeus's nomenclature. (Discussed by the President, Mr. G. M. Ash and Mr. A. W. Exell; Dr. Sprague and Dr. Ramsbottom replied.)

The following papers were read in title :—

The *Combretum* species of the New World. By A. W. Exell, F.L.S. [Published in *Journ., Bot.*, No. **356**.]

Tropical Fungi. IV. New species and revisions. By C. G. Hansford, M.A., Sc.D., F.L.S.

THE PLAN OF THE SPECIES PLANTARUM

By T. A. Sprague.

The keynote of the *Species Plantarum* is economy—economy of time, of effort and of expense. Nothing unnecessary is included in it : the generic names appear without authors' names, references to places of publication or descriptions, such information of this nature as Linnaeus considered necessary being provided in his *Genera Plantarum*. The accepted specific diagnosis, reduced to a bare minimum, comes first ; then follow the synonyms arranged, not in chronological sequence, but according to their generic names, as recommended in the *Critica Botanica*, Aph. 319, 320 (1737) ; each begins a new line (Aph. 321). The synonymy of European species is drastically reduced by the omission of names prior to C. Bauhin's *Pinax* (Preface, p. 4). The 'habitat', followed by a symbol indicating the duration of life of the plant, and whether, if perennial, it is herbaceous or woody, rarely occupies more than a single line, and comes last, except for an occasional note, or a description of a new species (e.g. *Justicia chinensis*), or of an insufficiently described one (e.g. *Salvia hispanica*, *Euphorbia characias*). 'Habitat' includes geographical distribution as well as what is now termed habitat : information concerning the latter was generally known and supplied only for European species, e.g. *Genista anglica*, " Habitat in Angliae ericetis humidiusculis " ; *Carex fulva*, " in Europae paludibus " ; *C. hirta*, " in Europae sabulosis " ; *C. digitata*, " in Europae nemoribus ".

In order to save space, Linnaeus employed the astronomical symbols of Saturn, Jupiter, Mars and the Sun to denote woody, herbaceous perennial, biennial and annual plants respectively (Preface, p. 4), and Mercury, Mars and Venus for the hermaphrodite, male and female conditions, the same symbol, that of Mars, thus standing for both biennial and male. It is not obvious why he should have used this in two different senses, since the symbol of the Earth was available for one of them, though Uranus and Neptune were then undiscovered. Perhaps, when he began writing his manuscript of the *Species Plantarum* in 1746, he did not anticipate having to use signs for sex, which actually occur very rarely, namely, under *Spinacia oleracea*, *Cannabis sativa*, *Humulus lupulus*, *Tamus communis*, *Mercurialis perennis*, *M. annua*, *M. tomentosa*, *Hydrocharis morsus-ranae*, *Carica papaya*, *Clutia alaternoides*, *Nyssa aquatica*, *Arctopus echinatus* and *Ficus carica*. Imperfectly known species, e.g. *Orobus pyrenaicus*, *Taxus nucifera*, are marked with a dagger (Preface, p. 3) and references to good descriptions or figures with an asterisk.

The outstanding innovation in the *Species Plantarum* was of course the introduction of real names for species to replace the diagnostic phrases which had been used previously for purposes of reference. This was no sudden change, however, for Linnaeus had used the binary names *Hyacinthus botryoides* and *Fumaria bulbosa* in his *Iter Oelandicum et Gotlandicum* (1745), and *Viola palustris*, *Osmunda regalis*, *Cynosurus caeruleus* and *Aira caerulea* in his *Iter Scanicum* (1751), as pointed out in Richter, *Codex Botanicus Linnaeanus* (1840), p. xxix. All these he afterwards adopted in the *Species Plantarum*.

He called his new specific epithets 'nomina trivialia' (names for everyday use), and placed them in the margin, thus achieving a double purpose : drawing greater attention to them, and at the same time avoiding disturbance of the traditional method of citing the diagnostic phrase and its synonyms. But in *Flora Suecica*, ed. 2 (1754), he interpolated the trivial name in parentheses between the generic name and the specific diagnosis. Linnaeus must have appreciated to the full the time-saving value of his nomina trivialia, and he obviously expected other botanists to accept them and to propose new ones where these were required, for he cautions them against coining new trivials without a sufficient specific difference (Preface, p. 4).

Linnaeus could not have achieved his prodigious scientific output had he not been a very rapid worker, and it can hardly be supposed that he spent very much time in selecting his trivials. In polytypic genera they mostly indicate a salient diagnostic character, as in *Boerhavia erecta*, *B. diffusa*, *B. scandens* and *B. repens*, and in *Gentiana lutea*, *G. purpurea*, *G. punctata* and *G. asclepiadea*, but where such single characters were not immediately available, he had recourse to geographical names, e.g. *Salicornia europaea*, *S. arabica*, *S. virginica* and *S. caspica* ; to names derived from habitat, e.g. *Pedicularis palustris* and *P. sylvatica* ; to old generic names, e.g. *Clandestina*, *Phelypaea*, *Anblatum* and *Squamaria*, used for his four species of *Lathraea* ; to vernacular names, e.g. *Schinus molle*, *Spondias mombin* ; to names indicating use in pharmacy, or special medicinal properties, e.g. *Saponaria officinalis*, *Rhamnus catharticus* ; to the name of the describer, e.g. *Androsace halleri*, *Cortusa gmelini* ; or to the trivial of a species of another genus which the species concerned resembled, e.g. *Convolvulus medium*, so named because it recalled *Campanula medium*. In monotypic genera about half the trivials were taken from native country or habitat. An analysis of his first hundred specific epithets shows that 84 were taken directly or indirectly from his diagnoses, synonymy or habitat, or from names mentioned in the works cited. Thus the epithet of *Boerhavia repens* was taken from the specific diagnosis, 'caule repente' ; *Kaempferia rotunda* from the synonym, *Zedoaria rotunda* C. Bauh. ; *Amomum zerumbet* from *Zerumbet* Dale, cited in *Hort. Cliff.* p. 3 ; and *Justicia chinensis* and *Veronica arvensis* from the 'habitat'. Five common plants bear the epithet *vulgaris*, and three mentioned in L. *Mat. Med.* were called *officinalis*, whilst *Kaempferia galanga* was so named because Linnaeus thought it was a source of the drug Galanga. Of the seven remaining species, the name *Blitum virgatum* refers to the habit, *Justicia nasuta* to the peculiar upper lip of the corolla ; *Veronica spuria* and *V. hybrida* were putative hybrids, *V. peregrina* was an alien occurring in Sweden, and *V. verna* was an early-flowering species ; *Gratiola dubia* was so named because Linnaeus was uncertain whether it really belonged to that genus : in *Sp. Pl.*, ed. 2, he transferred it to *Capraria*, and in *Mant.* **2** to *Lindernia*. It is clear that Linnaeus, with his fertile imagination, did not have to spend much time in choosing his trivials.

The treatment of varieties in the *Species Plantarum* presents perplexing features which can be elucidated only by careful comparison of numerous examples. The *Critica Botanica* affords no help in this connection : Linnaeus there writes : "A varietal distinction can be placed at the end of a name by those who like to do so ; but be it far from me to give instruction in varietal names to distinguish them, and to circumscribe their limits—all such names being to my mind absurdities" (Aph. 306), "The species of Botanists come from the All-wise hand of the Almighty, the varieties of Florists have proceeded from the sport of Nature, especially under the auspices of the Gardeners" (sub Aph. 310). In his *Species Plantarum*, however, his concept of a variety had changed : it was no longer a mere florists' variety, unworthy of serious consideration by a botanist, but a respectable taxonomic group, although not sufficiently well marked to be treated as a species. Two methods of

dealing with varieties are found in *Sp. Pl.*: most frequently the variety or varieties are *appended* to the species, and are marked by the Greek letters β, γ, etc., the species (proper) being without a varietal letter. When the varieties were sufficiently well marked, they were given epithets distinguished from those of species by being in roman type. In some cases such appended varieties were regarded by Linnaeus as having arisen from the species under which they were placed: thus the Wild Almond, *Amygdalus communis*, has two varieties, β, the cultivated Sweet Almond, and γ, the Bitter Almond; the Wild Teasel, *Dipsacus fullonum*, has the cultivated Fullers' teasel as its var. β. Fenugreek, *Trigonella foenum-graecum*, forms an exception: here the wild plant is treated as a variety—it was not so well known as the cultivated one. The Common Elder, *Sambucus nigra*, is followed by a much scarcer green-fruited var. β, and an equally scarce var. γ with laciniate leaflets. The Common Myrtle has seven rarer named varieties. The Wild Sea-Beet, *Beta vulgaris*, is followed by seven cultivated varieties, only two of which, the Common Beetroot, β *rubra*, and the White Beet, γ *cicla*, were deemed worthy of distinctive epithets. In this instance Linnaeus departed from his usual practice by giving a distinctive epithet, *perennis*, to his taxonomic type—probably to indicate that it differed from all the cultivated varieties in being perennial. Similarly he gave a distinctive epithet, *tenuifolius*, to *Euonymus europaeus*, to contrast with his var. β *latifolius*. From these examples it would appear that Linnaeus usually treated the wild form, or the best-known one, or the commonest, as the species (proper), and the cultivated, less-known, or rarer forms as varieties.

Linnaeus sometimes adopted a different method of dealing with varieties, in which the species was subdivided into two or more apparently *co-ordinate* varieties, α, β, γ, etc., none of which was explicitly indicated as typical. Thus *Crocus sativus* was subdivided into var. α *officinalis*, flowering in autumn, and var. β *vernus*, flowering in spring. *Magnolia virginiana* was subdivided into five named varieties, α *glauca*, β *foetida*, γ *grisea*, δ *tripetala*, ϵ *acuminata*. *Valeriana locusta* also consisted of five named varieties, from Europe, Crete, Portugal, Southern Europe and Maryland respectively. Representative geographical varieties occur also under *Achyranthes aspera* (vars. α *sicula*, β *indica*), *Aloe hyacinthoides* (vars. α *zeylanica*, β *guineensis*), and *Hemerocallis lilio-Asphodelus*, with var. α *flavus*, from Hungary and Siberia, and var. β *fulvus*, from the East Indies.

Difficulties in typification have inevitably arisen from this two-fold treatment of varieties by Linnaeus, and from inconsistencies in each method. Some authors have retained the specific epithet of *Valeriana locusta* (*Valerianella locusta*) for his var. α *olitoria*, whereas others have rejected it in favour of *olitoria*. Here the diagnostic phrase in *Sp. Pl.*, ed. 1 is followed by a reference which may perhaps be regarded as typifying the specific epithet. In *Magnolia virginiana* such references are also present, but in *Sp. Pl.*, ed. 2 (1762) Linnaeus himself rejected the name *M. virginiana*, giving new specific names to four out of five of his varieties, namely *M. glauca* (var. α), *M. grandiflora* (var. β), *M. tripetala* (var. δ) and *M. acuminata* (var. ϵ), and apparently including the fifth, var. γ *grisea*, under *M. glauca* (vide Richter, *Cod. Bot. Linn.* 534, n. 2982). As the synonym, *Magnolia foliis ovato-lanceolatis Hort. Cliff.* 222, is cited by Linnaeus both under *M. virginiana* in *Sp. Pl.*, ed. 1, and under *M. glauca* in *Sp. Pl.*, ed. 2, it would appear that in 1762 he regarded var. *glauca* as the typical element of *M. virginiana*, and the name *M. virginiana* is now retained for Clifford's plant with *M. glauca* as a synonym. *Sisymbrium amphibium* L. *Sp. Pl.*, ed. 1, has three varieties α *palustre*, β *aquaticum* and γ *terrestre* (erroneously lettered δ). In *Fl. Suec.*, ed. 2, the varieties α and β were transposed. In this instance it is the var. β which has retained the specific epithet *amphibium* on segregation, as *Rorippa amphibia* (L.) Besser, while var. α now bears the

name *R. islandica* (Oeder) Borbás, with *Nasturtium palustre* (L.) DC. as a synonym. Such examples illustrate some of the difficulties encountered in typifying Linnaean specific epithets: each case has to be settled on its own merits.

Even where there is no var. α, the type of a Linnaean specific name is not always easy to determine. The taxonomic type (i.e. original form) of *Dipsacus fullonum* is obviously the wild plant, but it may be argued that the nomenclatural type was the var. β, the cultivated plant used by fullers for raising the nap on cloth, since that was the source of the name. *D. fullonum* is now subdivided into two subspecies, *sylvestris* (the wild plant) and *fullonum* (the cultivated one). Unless the name *D. fullonum* is typified by its var. β, the wild plant will have to bear the name *D. fullonum* subsp. *fullonum*, and a new name will have to be found for the cultivated Fullers' teasel (*International Code*, Art. 35). The case of *Ochna jabotapita* is illuminating: the species (proper) is a Ceylon plant, *Ochna* L. *Fl. Zeyl.* 209, with the synonym *Japotapita cinnami folio, floribus spicatis* Burm. *Zeyl.* 123, t. 56. There is a var. β from Africa, and a var. γ *jabotapita* Marcgr. from Brazil. One might have supposed that Linnaeus would have retained the name *Ochna Jabotapita* for the species (proper), as defined by his and Burmann's descriptions, yet when in *Sp. Pl.*, ed. 2, he separated the American var. γ *jabotapita* as a distinct species, he retained the name *Ochna jabotapita* for it, and coined a new name, *O. squarrosa* for the Ceylon plant with its African var. β. To him it would have seemed absurd to retain the name *O. jabotapita* for anything but the true and original Jabotapita of Brazil. The cases of *Dipsacus fullonum* and *Ochna japotapita* suggest that, in typifying Linnaean specific names, the *origin* of the epithet is an important element, which should be taken into consideration.

Mention should be made of the generic names employed by Linnaeus in the *Species Plantarum*, though a full discussion of these is more appropriate to a review of the *Genera Plantarum*. One of his important reforms was the rejection of generic names formed from two complete and distinct words. His reforming zeal was tempered, however, by a desire for continuity in nomenclature. Thus the generic names *Bella donna, Bursa pastoris, Crista galli, Lacryma Jobi, Melo pepo, Morsus ranae, Nidus avis, Ruta muraria, Uva Ursi, Virga aurea* and *Vitis idaea*, which he replaced by *Atropa, Thlaspi, Rhinanthus, Coix, Cucurbita, Hydrocharis, Neottia, Asplenium, Arbutus, Solidago* and *Vaccinium*, were retained by him as specific epithets under the latter. In other cases, e.g. *Caryophyllus aromaticus, Canna indica* and *Primula veris*, he retained the first word as the generic name, and the second as the specific epithet. Sometimes the idea underlying the old generic name was retained in the new: thus he replaced *Coma aurea* by *Chrysocoma, Dens leonis* by *Leontodon*, and *Ferrum equinum* by *Hippocrepis*.

Linnaeus considered that generic names not containing a root derived from Greek or Latin should be rejected (*Crit. Bot.*, Aph. 229). He retained 'barbarous', i.e. non-European names, however, when he could find a root suggesting a possible derivation from Latin or Greek, in which case he treated such names as new coinages, e.g. *Datura* from Latin *dare* to give, because it is given to those whose powers are enfeebled. Out of 80 'barbarous' generic names listed by him (*Crit. Bot.*, sub Aph. 229) he retained nine, namely, *Berberis, Carthamus, Doronicum, Datura, Guajacum, Marrubium, Melochia, Musa* and *Yucca*, and modified a tenth, *Mammei* to *Mammea*. Of the remaining 70 he absolutely rejected 21 (30 per cent), but retained the other 49 (70 per cent) as specific or (in one case) varietal epithets under their new generic names, thus maintaining a large measure of nomenclatural continuity. Among such specific names are *Melia azedarach, Lantana camara, Peganum harmala, Salsola kali, Zea mays, Hippomane mancinella, Ipomoea quamoclit* and *Rheum rhabarbarum*. He was satisfied if a generic name looked and sounded

like a Greek or Latin word. Thus he coined the name *Cheiranthus*, which on the face of it seems to mean ' hand flower ', whereas its first element was Cheiri, the Arabic name of the Wallflower, so that *Cheiranthus* really means ' Cheiri flower '. When he gave a specific epithet in *Sp. Pl.*, ed. 1, he unfortunately chose *Cheiri*, thus forming the tautological name *Cheiranthus cheiri*, or ' Cheiri Cheiri-flower '.

Linnaeus rejected the four generic names *Lens*, *Lenticula*, *Lenticularia* and *Lentibularia* as being too much alike, and replaced *Lentibularia* by *Utricularia*, the retention of the last four syllables serving as a connecting link or mnemonic. He had no scruples about employing a classical plant name in quite a different sense, if it was not used with its proper meaning by the botanists of his day. Thus he substituted *Melia*, the Greek name of *Fraxinus ornus*, for the 'barbarous' generic name *Azedarach*—here the connecting link is that both *Fraxinus* and *Melia* are trees with pinnate leaves. *Hippuris* is the Greek name of *Equisetum*, but he used it for a Flowering Plant of similar appearance. He was very strongly opposed to generic names being used to honour persons other than celebrated botanists and patrons of the science. When he rejected the generic name *Bonarota* Mich. because it commemorated a Senator of Florence unknown to botany, he proposed *Paederota* (' Child's hoop '), in which the last two syllables are the same, as a substitute, and emphasized the connection between the two generic names in *Sp. Pl.*, ed. 2, by calling the species *Paederota bonarota*, i.e. *Paederota*, olim *Bonarota*. Many other instances might be given of the importance which he attached to avoiding an absolute break in botanical nomenclature.

The Latin which Linnaeus wrote was mediaeval Latin, and he adopted the mediaeval spelling (with a ' y ' instead of an ' i ') of the generic names *Pyrus* and *Pyrola*, and of the epithets *hybernus*, *hyemalis*, *sylvestris* and *sylvaticus*. Under the *International Code*, Art. 82, these spellings must be retained, though the correct classical spelling with an ' i ' is recommended in Rec. 82 F for new epithets. In forming a compound name or epithet derived from two Latin words, the final stem-vowel of the first word (whether this is masculine, feminine or neuter) should be reduced to ' i ' before a consonant, as in *Sium nodiflorum* (from nodus), *Senecio erucifolius* (from *Eruca*) and *Alopecurus hordeiformis* (from *Hordeum*). Where the first word was a feminine noun ending in -a, Linnaeus sometimes used the vowels ' ae ' instead of ' i ', as in *Hermannia althaeaefolia*, where he may have been unconsciously influenced by the synonym, *Hermannia capensis althaeae folio* Pet., in *Veronica hederaefolia* (*Alsine hederulae folio* C. Bauh.), *Passiflora tiliaefolia* (*Granadilla pomifera, tiliae folio* Plum.) and *Hypnum spinaeforme*. In these and similar cases the ' ae ' is now replaced by ' i ' in accordance with Art. 82, Note 2. In other instances Linnaeus formed his compound specific epithets in accordance with classical usage, as in *Cardamine resedifolia*, *Scutellaria hastifolia* and *Sida periplocifolia*.

Some idea of the immense labour entailed in preparing the *Species Plantarum* may be formed from the fact that it included 5,938 species classified under 1,098 genera. It is difficult to estimate precisely the number of new species, but if all those described without any synonym, or with only a queried synonym, are included, there are about 285. Curiously enough, the number of species catalogued in Caspar Bauhin's *Pinax*, 130 years earlier, was also about 6,000, but many of these were mere states of common wild plants, such as the spotted and unspotted forms of *Arum maculatum*, while others were mere horticultural forms. In his preface Linnaeus stated that the number of species of plants in the whole world was much smaller than was commonly believed, and that it could hardly exceed 10,000. If we are inclined to smile at this estimate, even after allowing for the small number (400) of Thallophytes known to Linnaeus, let us remember that in 1908 the species of Flowering Plants were estimated

by Thonner at 136,000, and that since that date at least 4,000 new ones have been added per annum. Even assuming that a quarter of these are rejected by monographers, the total at the present date probably stands at about 275,000. Who would have thought that the estimated number in this group would have doubled in less than fifty years ?

Works consulted.

Bauhin, Caspar. 1623. *Pinax Theatri Botanici.*
Linnaeus, C. 1938. *Critica Botanica,* translated by Sir A. Hort.
Richter, H. E. 1840. *Codex Botanicus Linnaeanus.*
Sprague, T. A. 1953. Linnaeus as a Nomenclaturist. *Taxon,* **2,** 40–46.
Thonner, Franz. 1908. *Die Blütenplanzen Afrikas.*

LINNAEUS'S 'SPECIES PLANTARUM'; THE MAN AND THE BOOK

By J. S. L. Gilmour.

It is a striking fact that, although Linnaeus's *Species Plantarum* is, to botanists, his best—and often only—known book, it receives very scant mention in the many accounts that have been written of his life. On further consideration, however, the reason for this neglect is not far to seek. Happy marriages do not make front-page news, and the *Species Plantarum*—with its masterly diagnoses and neat bi-verbal nomenclature—was such a non-controversial and unanswerable reply to the ever-growing problems of mid-eighteenth century plant taxonomy, that the contemporary world—and subsequent biographers—could only accept it, without cavil, in gratitude and admiration.

What were Linnaeus's position and circumstances when he wrote and published his greatest botanical work, and how did he carry out the enormous task that he had set himself ?

The *Species Plantarum* was first published in 1753 when Linnaeus was 46 and had already written the great bulk of his major works. He lived a further 25 years, but he published little more of first importance, and the *Species Plantarum* can be regarded as his crowning achievement. The manuscript was written between 1746 and 1752, and during the whole of this period—and indeed until his death—he was Professor of Botany and Medicine at Upsala University. He had been a student at the same University and his return there in 1741 was, in a double sense, a home-coming, since it meant also a return from medical practice in Stockholm to his first love, Botany. He undoubtedly regarded his appointment at Upsala as a haven of rest after his years of rather hectic wandering in Europe and the strain of a fashionable practice in the Swedish capital. But, although he may have found mental relaxation, to the outward view his life in Upsala was the reverse of restful. Reading of his multifarious activities at this time, it is difficult to imagine how any human being could have carried them out, far less have written three or four books at the same time. Besides a heavy lecturing programme in Botany, Chemistry, Pathology, Dietetics, and Materia Medica, Linnaeus directed the botanic garden, supervized numerous private pupils, led botanical excursions near Upsala and as far afield as West Gotland and Skåne, kept up a voluminous correspondence with botanists all over the world, undertook time-consuming administrative work for the Medical Consistory and the Royal Society of Upsala, and, as if all this were not enough, took a real and personal interest in the affairs of the Smålands ' Nation ' at the University. How did he accomplish this prodigious output of work and find time also to write the *Species Plantarum* ?

The answer is, I think, twofold. In the first place he organized his life to a rigid time-table, rising, in the summer, at 3 or 4 a.m., and, having lit his pipe, beginning at once on his work for the day. In this self-discipline he was aided by a wife who, although far from ideal as an intellectual or spiritual partner, kept all domestic affairs in her own hands and left her husband free for his botanical work. And, of course, unlike most modern professors, Linnaeus had no need to move from the table to the study by way of the sink, and there were others to dig his garden for him on a Saturday afternoon.

But organization, and freedom from domestic tasks, are not enough to explain his phenomenal activity; a deeper reason must be found. It lies, surely, as in the case of other 17th and 18th century scientists, such as Ray, Boyle and Hales, in the inspiration and sense of mission derived from his profound religious piety. Linnaeus felt that he was interpreting the works of the Creator in all that he did, and this gave him a confidence and an exhilaration—occasionally passing over into something near conceit—that carried him triumphantly through his self-imposed tasks. That such inspiration is not essential to the work of a great scientist is proved, of course, by the life of Darwin and many others, but there is no doubt that, in Linnaeus's case, it was the force that produced the *Species Plantarum*.

There was, however, a reverse side to Linnaeus's religious exhilaration—a side shown by periods of brooding melancholia and self-distrust that temporarily incapacitated him. This aspect of his nature—and the strong poetic feeling that was perhaps linked with it—is brought out vividly in Knut Hagberg's recent book on Linnaeus, which gives a more complete picture of him as a man than any previous study.

I have tried so far, very inadequately, to give a brief glimpse of Linnaeus as he was when he wrote the *Species Plantarum*. I will close with a word or two about the book itself—not its contents, which have been covered by other speakers—but its early bibliographical history as a book.

Three editions were published in Linnaeus's life-time, and two Mantissas. The first edition (1753) is a rare book, especially the first of the two known issues, which has the three leaves, later cancelled, in their original form. There are four copies in the library of the Linnean Society, two with annotations by Linnaeus. The book appeared in two octavo volumes, printed by Salvius at Stockholm, and was dedicated to King Frederick and Queen Ulrika of Sweden. The second edition, considerably enlarged and issued with a portrait (which is often lacking in present-day copies), appeared, also in Stockholm, in 1762–3. One year later an edition usually known as the third was printed in Vienna, but it is merely a reprint of the second edition with the errata corrected. After Linnaeus's death in 1778 appeared the well-known fourth edition (1797–1830) edited by Willdenow and others, and there have been a number of indexes and facsimile reprints.

The two Mantissas, issued in Linnaeus's life-time, were published in 1767 and 1771. The second is interesting to Englishmen owing to its dedication to Frederick Calvert, 6th Lord Baltimore. He had visited Hammarby in 1769 and had later dedicated his privately printed *Gaudia Poetica Latina* . . . to Linnaeus. Lord Baltimore was a dilettante nobleman with a fantastic history; he was described by a contemporary as "one of those worn-out beings, a hipped Englishman, who had lost all moral and physical sense". He died at Naples at the age of 40, and bequeathed the province of Maryland, in the United States, to his illegitimate son, thereby helping, in some small degree, to precipitate the War of Independence.

Since the meeting at the Linnean Society a special number of *Taxon* has been devoted to the *Species Plantarum*, and in it will be found much further bibliographical information by Felix Bryk about Linnaeus's great book—the foundation-stone of modern botanical taxonomy.

LINNAEUS'S 'SPECIES PLANTARUM' AND THE LANGUAGE OF BOTANY

By William T. Stearn.

A great work prepared through the exercise of the imagination, whether it relates to art or science or is a mingling of the two, always proves worthy of study from more viewpoints than its author envisaged. Linnaeus's *Species Plantarum*, first published in 1753, and *Pantagruel* by François Rabelais, who died in 1553, are indeed very diverse works, but to mention them together is by no means so fantastic as might first appear. The advice which Linnaeus gave his students, prompting the more adventurous to go far afield, some to die in distant lands, as Loefling in South America, Berlin in West Africa, Hasselquist in Turkey, Forsskål in Arabia, Tårnstrom in Indo-China, Adler in Java, but others to return laden with a rich store of observations and specimens new to science, as Kalm from eastern North America, Afzelius from West Africa, Osbeck from China, Thunberg from Japan and the Cape, Solander and Sparrman from voyaging with Captain Cook across the uncharted Pacific Ocean, was essentially the same as that which Rabelais had put into the mouth of Gargantua some two centuries earlier. It set a Utopian ideal, still far from realization. "To a study of the works of nature," wrote Gargantua from Utopia to Pantagruel in Paris, "I wish you to give yourself zealously that there may be no sea, river or fountain of which you do not know the fish; all the birds of the air, all the trees and shrubs of the forest, all the herbs growing on the ground, all the metals hidden in chasms, the precious stones of all the Orient and southern lands, none should be unknown to you" (*Pantagruel*, book 2, chap. 8). It became the life-task of Linnaeus to organize such knowledge into a system and to give it formal expression. In the field of botany, within which Linnaeus himself considered the *Species Plantarum* to be his greatest achievement, he contributed largely to the development of a special technical language for the purpose, one which by its economy of words was far removed from Rabelais's coarse verbal exuberance.

Around such a great work there commonly grows up a small and sometimes indeed a vast library of comment and criticism, devoted to (1) its basic material, (2) the process and technique of its creation, (3) the work itself, its aim, achievement and shortcomings, its influence and its bibliography. The basic material of the *Species Plantarum* (1753) is to be found, of course, in the personality of Linnaeus and the state of botany when he wrote. Since these and other major matters relating to the *Species Plantarum* are being discussed on this bicentenary occasion by other people, my purpose here is simply to make a few observations about a lesser but nevertheless important one, the language of the *Species Plantarum*, although even this is so closely connected with the subject matter of other papers that some overlap and repetition become inevitable. Linnaeus was born in 1707 in Småland, Sweden. When he published the *Species Plantarum* he was 46 years old and at the height of his powers; his long wane had not begun. The *Species Plantarum* is thus the culmination of many years of thought and enquiry, during which he had travelled in Lapland, Sweden and Holland, had seen many plants and had written his *Systema Naturae* (1735), *Genera Plantarum* (1737), *Hortus Cliffortianus* (1737), *Critica Botanica* (1737)*, *Flora Lapponica* (1737), *Flora Succica* (1745), and *Philosophia Botanica* (1751). Of these years the most important were those of

* Quotations of this work are from Arthur Hort's translation into English, *The 'Critica Botanica" of Linnaeus* (Ray Soc. Publ., n.124; 1938).

1735–37 which Linnaeus spent in Holland; here the rich library of George Clifford at Hartekamp made available to him all the relevant literature, most of it written in Latin. Today a systematist covering the same wide field must know Latin, English, French and German at least, and for certain groups he must also be acquainted with the Italian, Portuguese, Scandinavian, Slavonic and Spanish languages, so that, to quote Linnaeus's words of 1737, " a novice may grow old over his literary studies before he is competent to study the sciences ". But for the survival of Latin as an academic language, Linnaeus himself could have accomplished only a small part of his massive and valuable work. He learned it with difficulty at school, for he seems to have had no talent for languages as distinct from collections of words, but it was an invaluable acquisition. It became his passport to the society of Boerhaave, Gronovius, Clifford and other learned foreigners who befriended him. It gave him an international public such as he could never have reached by writing in any modern language with the possible exception of French, certainly not by means of his native Swedish. Latin had ceased to be the language in which a student wrote home for a new pair of boots, but it was still a live medieval legacy, still the language of academic disputations, learned correspondence and international books. As used in these it had diverged a long way from classical Latin. In Linnaeus's hands it diverged even more; out of it he created a new Romance language, botanical Latin. He did this at the very time that two Italian scholars, Facciolati and Forcellini, were trying to purge Latin of its accumulated barbarisms by producing their great compendium of classical usage, *Totius Latinitatis Lexicon*. This new language grew under Linnaeus's hands as he laboured at the works mentioned, for the *Species Plantarum* and the *Genera Plantarum* demonstrate in practice and action the principles and precepts set out in the *Philosophia Botanica* and the *Critica Botanica*.

Together these books are an astonishing achievement. Linnaeus was obviously impelled to undertake them by his lively imagination which enabled him to see in the vast diversity of the realm of Nature an orderly whole, a kind of unexplored kingdom which it was his destiny to explore and to reveal on behalf of the Creator. In this he was aided by a strong visual memory enabling him to hold in his mind the characteristics of many organisms, from which he could select those special features suiting his scheme of classification. He longed for symmetry, analysing everything into subdivisions which were comparable and balanced one another. These qualities would not, however, have taken him very far without his zeal and his capacity for really hard mental drudgery. Linnaeus was able to turn them to such good use by that personal characteristic which made so many people dislike him on first acquaintance, his well-founded self-confidence which at times seemed to pass into mental arrogance. Its effect on the language of botany may be illustrated by a reference to *Through the Looking Glass* by Lewis Carroll, who (as the Rev. Charles Dodgson) was a distinguished mathematician well acquainted with the problems of definition and logic. Here Humpty Dumpty contemptuously dismissed Alice's objection that the word ' glory ' does not mean " a nice knock-down argument " by dogmatically asserting that " When I use a word, it means just what I choose it to mean—neither more nor less ". " The question is," Alice then said, " whether you *can* make words mean different things." " The question is," said Humpty Dumpty, " which is to be master –that's all." Linnaeus felt himself so much the master of botanical speech that he deliberately imposed upon a number of classical words special meanings they had never had before. This process of deliberately and arbitrarily choosing a name for a certain thing is called *stipulative definition* by R. Robinson in his book *Definition* (1950), where it is discussed at length, and is to be distinguished from *lexical definition*, which describes how words have already been used.

That Linnaeus dared to employ stipulative definition as much as he did seems to be associated with the well-marked poetic and artistic side of his temperament, for a great artist is necessarily a confirmed individualist who follows authority only so far as it suits his purpose and who treats his material sympathetically but masterfully. "Anything that God or nature, philosophy or science, politics or history or art itself can give him is not going to be accepted as something finished and as such to be respected. It is going to be reduced to the level of raw material for a new creation." Such, in the words of Dorothy Walsh (*Philosphical Review*, **25,** 436, 1943), is essentially the artist's attitude towards his material. Such was Linnaeus's attitude towards language.

Linnaeus's mission being to record in an ordinary manner the works of the Creator, he had to do so with precision, clarity and conciseness—with precision, because of his respect for facts and because to do otherwise would be misinterpreting the Creator's work; with clarity, because he wished to be widely understood; with conciseness, because otherwise he could never have got through so massive a task, nor have achieved publication. This task was essentially descriptive. Anyone who sets out to describe an organism quickly meets difficulties of terminology. For ordinary things of common observation, everyday language suffices; for technical purposes it is rarely adequate. Thus the Greeks and Romans had a host of words for plant structures that interested them economically, for shoots, branches, trunks, wands, withies, berries, apples, pears, etc., but not for details of floral structure. Late in the seventeenth century Grew and Malpighi had opened the eyes of botanists on the amazing diversity of minute floral structure and details and other features of plants which had hitherto been ignored and which consequently had never been consistently described and named. In such circumstances, several kinds of linguistic action are possible. (1) The new thing to be named can be given an entirely new name constructed arbitrarily of any sounds one likes. (2) A word of wider application covering the new thing can be restricted to it. (3) A word already in use for something else can be transferred to it. (4) A new word can be compounded out of existing relevant words. Whichever course is followed, it is essential to state the meaning henceforth to be associated with the word, linking the word so closely with a concept that the use of the word implies that concept. This Linnaeus did, first in his *Fundamenta Botanica* (1736), then in his *Philosophia Botanica* (1751), thus making possible the success of his *Species Plantarum*. The new language of botanical Latin here created has proved of the utmost value to systematic botany as an international science and is linguistically interesting as it parallels in its development part of the change from Old Latin into Vulgar Latin and the Romance languages. Botanical Latin often horrifies classical scholars concerned primarily with the best literary remains of a limited period of Roman history. "The latinity of the natural historians has undergone no small censure", observed the Rev. John Brand in 1795, but he then pointed out that the innovations which Linnaeus and others made were essentially of the same kind as those the Romans themselves had made when Latin was their native living language. They faced similar problems in dealing with philosophy and grammar—abstract matters outside everyday experience and language. The problem was discussed by Varro and Cicero, whose works, it is interesting to note, were edited by the father of Linnaeus's friend Gronovius. "Aut enim nova sunt rerum novarum facienda nomina aut ex aliis transferenda", said Varro. "To new things new names must be given or those of others transferred to them." This liberty, Varro pointed out, was taken by the Greeks and it was even more necessary for the Romans who, having cultivated philosophy for a much shorter time, lacked appropriate words. Linnaeus acted in accordance with this classical tradition. He did not set out to make a new language but simply to adapt Latin to meet the needs of a growing science. Notable features of botanical

Latin are its avoidance of verbs, its restricted number of nouns, often with special meanings distinct from those of classical Latin, and its rich store of adjectives. It has simplified the grammar of classical Latin and vastly increased its technical vocabulary. In Linnaeus's *Philosophia Botanica* we have its first textbook; his *Species Plantarum* and *Genera Plantarum* demonstrate its effective use. It is desirable always to consider these works as closely linked. Under the International Code of Botanical Nomenclature "it is agreed to associate generic names which appear in Linnaeus's *Species Plantarum* ed. 1 (1753) and ed. 2 (1762–63) with the subsequent description given under those names in Linnaeus's *Genera Plantarum* ed. 5 (1754) and ed. 6 (1764)". Linnaeus relied as much as possible on easily visible characters, notably those of the leaves, for the differentiation of species in the *Species Plantarum* and used floral and fruiting characteristics for generic distinction in the *Genera Plantarum*. Hence neither work by itself shows the full range and capabilities of Linnaeus's botanical vocabulary.

The sources of this vocabulary can be easily found. There were many among Linnaeus's predecessors who had described plants with remarkable skill and accuracy: Valerius Cordus, Charles de l'Escluse (Carolus Clusius) and John Ray come at once to mind as early masters of phytography. Ray had to deal with a much greater range of plants than Cordus and Clusius and he gave thought to terminology: to Ray, Linnaeus's debt, as he himself indicated, was great. Not only did Ray set out a glossary; he introduced Linnaeus to the posthumous work of Joachim Jung (d. 1657), *Isagoge Phytoscopica*, with its systematic analysis of plant form by shape and position and its logical terminology. Of honest and generous disposition, Ray was able to assess critically the work of his predecessors, select what was best and give them full credit, never seeking to build up his own reputation by plagiarism from lesser men. He noted, for example, Fabio Colonna's suggestion — it was no more than a suggestion—that the Greek word *petalon* (πεταλον) should be used to designate a division of the coloured part of the flower (the *corolla* as, following Linnaeus, it is called now) and he adopted it. Thus *petalum* was added to botanical Latin and *petal* to the English language. Linnaeus carried on the process. He achieved success because he defined his terms on the basis of a wide botanical knowledge and used them economically and fairly consistently with the intent that the same word should always bear the same meaning and all unnecessary words be avoided. "For beauty and perfection science requires conciseness and brevity" he said. "The All-wise Author of Nature showed such conciseness in making all things, that conciseness could go no further. . . It is for us to marvel at the Omniscience of the All-wise Creator, and so far as in us lies, to approximate to that end beyond which the human intellect cannot go." To him the development of botanical language was thus part of his Heaven-sent mission. Certain that no genus contained more than a hundred true species—of *Solanum*, now considered to have over 1,000 species, he knew about 40; of *Senecio*, with over 2,000 species, he knew 46!—Linnaeus allowed himself at the utmost twelve words or terms to make a 'name' (a *nomen specificum legitimum*, in modern taxonomy a definition or diagnosis) which would distinguish a species from all others of the genus. In writing the *Species Plantarum* the formation of such concise definitions was his primary task. How modern is the language used can be demonstrated by taking the flower and examining quickly the origin of some common terms.

First comes *calyx*, a word used in ancient times for a variety of covering structures, e.g. the bud or calyx of a flower, the shell of an egg, the shell of a mollusc, etc., and first adapted in a limited botanical sense by Marcello Malpighi in 1651. Under it Linnaeus and his contemporaries included not only the calyx proper (their *perianthium*) but also various bracteal structures now distinguished as involucres, spathes and glumes. That is an example of a

word of wide application being restricted to one of the objects originally covered by it. *Corolla* means in Latin a ' little crown or garland '. In 1736 Linnaeus boldly adopted it for the inner coloured part of the flower, the *flos* of earlier authors ; he distinguished between the *tubus* and *limbus* of a gamopetalous corolla and the *unguis* (claw) and *lamina* of a single petal. That is an example of a word already in use being transferred to another object. *Petalum* he took from Ray's work. *Stamen* (thread) had been applied metaphorically by Pliny in the first century A.D. to the stamens of *Lilium* and it is difficult to ascertain who first used the word in a definite scientific sense, but certainly Linnaeus gave it modern currency ; he likewise adopted *filamentum* (thread) as a term for part of a stamen. *Anthera,* meaning a ' medicine made with flowers ', he took from the herbalists and converted it into a scientific term, rejecting the words *apex, capitulum, capsula, testiculus* and *theca* which others had used. He likewise chose *pollen* (a fine flour) rather than *pulvis*. From him we have the use of *stylus* with *y* rather than the preferable *stilus* with *i*. *Stigma* (spot) was also introduced by Linnaeus as the name for the pollen-receptive area of the style. It will be noted that a few of these terms are classical words which in botany now possess only one of their classical meanings, e.g. *calyx* and *stamen* ; some have a botanical use diverging little from classical use, e.g. *filamentum* ; most, however, such as *corolla, petalum, anthera, pollen, pistillum, stylus* and *stigma,* are classical words given new specialized meanings. They commended themselves to Linnaeus by their simplicity. He laid it down that " the terms of a specific name [i.e. a diagnosis or definition] should not be compounds, like generic names, nor Greek, but only Latin ; for the simpler they are the better " (*Crit. Bot.* n. 295). He thus did not avail himself of the opportunity to compound new terms out of existing relevant words as later botanists have done so freely. The invention of new words which have no root and no derivation, the first kind of linguistic action mentioned earlier, was utterly abhorrent to Linnaeus, as his remarks on ' primitives ' as generic names make clear (cf. *Crit. Bot.* n. 220).

Thus while labouring at the task which resulted in the *Species Plantarum* Linnaeus fashioned a new language out of a very old one. The writing of that book extended over at least six years (for he was hard at work upon it in September 1746, completing it in June 1752) and proved an exhausting task. About halfway through, certainly by December 1749 (when the dissertation *Pan Suecicus* was presented by his student N. L. Hesselgren), Linnaeus made the innovation whereby the *Species Plantarum* has become the starting point of modern botanical nomenclature : he introduced consistent biverbal names for species. However, the introduction of short convenient specific epithets for everyday use (*nomina trivialia* he called them, almost apologetically), which did not need continual revision, was never a primary object of the *Species Plantarum*. As already indicated, to Linnaeus the true specific name (*nomen specificum legitium*) was not an arbitrarily formed biverbal name but a descriptive name which distinguished the plant from all others of its own genus, by expressing differential characters imprinted by the Creator on the plant itself. These features should be those of parts readily to be observed but not variable. From this viewpoint leaves often afforded him the most elegant and natural differences, and in the *Species Plantarum* he used leaf-characters whenever possible. Earlier, in the *Hortus Cliffortianus,* he had provided an illustrated guide to his terminology for leaf-form.

Taken together the Linnean *nomina specifica legitima* provide a key to all the species of the genus known. The genus *Fraxinus,* for example, included three species to which Linnaeus in the *Species Plantarum* of 1753 gave the *nomina trivialia* of *excelsior* (No. 1), *Ornus* (No. 2) and *americana* (No. 3).

Their *nomina specifica* were as follows :—

1. Fraxinus foliolis serratis, floribus apetalis.
2. Fraxinus foliolis serratis, floribus corollatis.
3. Fraxinus foliolis integerrimis, petiolis teretibus.

Arranged as a modern indented key they become :

foliolis serratis	
floribus apetalis	1. *F. excelsior*
floribus corollatis	2. *F. Ornus*
foliolis integerrimis	3. *F. americana*

In 1737, when Linnaeus knew only the first two species, he had named them *Fraxinus floribus nudis* and *Fraxinus floribus completis*. The discovery of a third species (Catesby's *Fraxinus caroliniensis, foliis angustioribus utrinque acuminatis pendulis*) made it necessary for Linnaeus to amend the names of these two by adding details distinguishing them from the third. As Linnaeus himself said, " He who discovers a new species in some genus under which others have previously been discovered and named, should not only give his new species a good specific name, but should also correct or amend or add to the specific names of the other members of the genus, which otherwise would now become inadequate " (*Crit. Bot.* n. 294). The major advantage of the biverbal system was to make the name of a species independent of such changes in definition. Gradually the *nomen specificum* ceased to be regarded as the true name of the species and became instead the means of ascertaining the *nomen triviale*. As more species were discovered, the Linnaean twelve-word limit had to be abandoned but the Linnaean method of definition retained its utility and by its success led to wide adoption of the associated vocabulary, so that equivalent terms have found their way from Linnaeus's botanical Latin into modern languages. For the Romance languages their assimilation was easy, Latin forming the basis of all. Their adoption by English writers was deliberate but not inevitable. In a letter addressed to the President of the newly founded Linnean Society and read on 6 October 1789, the Rev. Thomas Martyn ventured " to affirm, that the Linnean language will continue to be in use, even though his system should in after ages be neglected ". To create in English a botanical vocabulary " suitable to every rank and condition, a language that may be incorporated into the general fund, and carry with it the proper marks of the mother-tongue ", Martyn submitted " these two fundamental principles : first, that we should adhere as closely as possible to the Linnean language itself : and secondly, that we should adapt the terminations, plurals, compounds and derivatives, to the structure and genius of our sterling English. That we ought to adopt the Linnean terms themselves, is sufficiently apparent from the great advantage resulting from the use of one universal language. If we change or translate these terms, we lose all this advantage, and become unintelligible to botanists of every other nation, without any benefit gained on the other hand : for these new terms will be equally difficult even to the English student ; and will require as much explanation as the Latin or Greek. . . . Thus, for instance, in the parts of fructification, if we adopt the terms *empalement, blossom, chive, thread, tip, pointal, seed-bud, shaft, summit,* they require explanation, in their appropriate sense, as much as *calyx, corolla, stamen, filament, anthera, pistillum* or *pistil, germen* or *germ, style* and *stigma*. . . For the same reason *legume* is to be preferred to *shell* or *cod, siliqua* or *silique* to *pod, silicle* to *pouch, glume* to *husk* or *chaff, culm* to *straw, digitate* to *fingered, ovate* to *egged, pinnatifid* to *feather-cleft* " (*Trans. Linn. Soc. London*, **1**, 148, 1791). The agreement of Martyn, Smith, and other leaders of British botany

upon this policy, " that all who talk or write of Botany in English, should keep as close as possible to the Linnean language ", rests largely upon Linnaeus's achievement of the *Species Plantarum*. On the language of botany in English, French, Italian, Portuguese, Romanian and Spanish, no less than in botanical Latin, the influence of that great work has been far-reaching and permanent.

LINNAEUS'S NOMENCLATURE

By J. Ramsbottom.

There is obvious relation in the different aspects of Linnaeus's *Species Plantarum* we are considering this evening—the man, his language and his *magnum opus*.

My contribution has to deal with his adoption of binomial or binary nomenclature in *Species Plantarum*—the beginning of our modern system of plant names. The change brought about in botany will be realized if the third edition of Ray's *Synopsis*, 1724 is compared with Linnaeus's *Species Plantarum*, 1753.

The *Synopsis* begins with Fungi and so it will be convenient to summarize some remarks I have made in a New Naturalist volume to be published shortly. The account starts, " 1. Fungus campestris albus superne, inferne rubens "—J. Bauhin's name, to which full references are given. But this is followed by C. Bauhin's name given equally fully, followed similarly by those of Sterbeek, and of Parkinson. There is no description other than is contained in the names. " Champignon " is added, the habitat and the season of growth. As J. Bauhin's name is given first, though it is not the oldest, it was considered to be the most descriptive, and presumably to be favoured by adoption.

This is simple but is not followed consistently; for some species we find a phrase name written separately, and then a description; for some of the new species (added by Dillenius) there is nothing beyond a description—which may contain up to seventy words or more. Jacob, struggling with an angel and asking " What is thy name ?", could not have been more perplexed than an early mycologist, having identified a fungus, wishing to speak of it. It is astonishing that the brilliant naturalists of those days did not hit upon some less clumsy method. The trouble was not that they were uninterested in names—that is a very recent pose—but, as often, logic and also undue regard for the classics led them on. Greek authors who wrote about plants were writing for the people (without publishers' blurbs and press notices), and they used the names of everyday speech; occasionally more than one for the same plant obviously drawn from different localities. Some of these names are still in use. I have previously related here how a native shepherd at Mycenae named a plant *heliotropion*, the same usage as that of Theophrastus, about 300 B.C., for what we know as *Heliotropium supinum*.

In Theophrastus, *Enquiry into Plants*, about five hundred plant names are mentioned. All are nouns, or nouns qualified by an adjective, whether of genus, species or variety. When, later, the Romans began to take an interest in plants, they based their ideas on those of the Greeks. They used Latin names for the species known to them; for others they borrowed from Greek authors, particularly Theophrastus. Consequently almost all their names are of the same kind as those of the Greeks, namely a noun or a noun and an adjective—the latter always written as two words, no matter what the Greek form. Thus it comes about that plant names of the old Herbals, taken from ancient writings, have a much more modern look than those of the first half of the 18th century.

Though ' generic ' names were rarely descriptive, the qualifying adjective was invariably so. As long as comparatively few species of a genus were known it was simple to give them distinctive names of this kind. As knowledge increased, so simple a nomenclature was sure to break down. It did so almost at once with fungi. Pliny distinguished three truffles as *Tuber colore nigro*, *Tuber colore intus candido*, and *Tuber colore rufo*. When he dealt with *boletus* (the modern *Amanita*), boletus itself is the edible *Amanita caesarea*, of high repute, whereas *Amanita muscaria* had fifteen words of description and *Amenita pantherina* twelve.

Similarly, in the period following that of the herbalists, when the spread of knowledge and the opening up of new lands had enormously increased the number of known plants, a distinguishing or descriptive phrase replaced the descriptive adjective. Some authors showed considerable ingenuity in keeping these phrases wthin reasonable bounds, others left nothing out and the name was, in fact, a detailed description. There were no conventions, and there were no rules. Everyone played the game according to his rights—or what he considered his rights. The result was that the study of natural history was needlessly hampered and confused. As I have put it, it was becoming as difficult to find a way through the tangle as it would be to travel hopefully if all places had such descriptive names as LLANFAIRPWLLGWYNGYLLGOGERYCHWYRNDROBWLLLLANDYSILIOGOGOGOCH.

Linnaeus was a systematist. He liked to have everything in ordered array. His *Fundamenta Botanica* expanded into *Critica Botanica* in 1737, where he puts forward his ideas about systematic botany, often with a pleasing sense of humour, shows him at his best. (When preparing my Presidential Address to the Society on " Linnaeus and the species concept " I came to the belief that *Philosophia Botanica* was more in the nature of a text-book for students than a philosophic discourse.)

In *Critica Botanica* he inveighs against sesquipedalian generic names: he suggested a limit of twelve letters. He also set himself a maximum of twelve words as against the all-long specific names used by some botanists but " the specific names should admit no terms than those necessary to distinguish one species of a genus from another ": " the shorter a specific name, the better also it is—if only such a name can be found ". As a step towards this he distinguished between two types of specific names, *essential* and *synoptic*, the first giving the essential characters of differentiation, the second separating off characters common to several species of a genus—what we now call sections of a genus. As written for *Salix* they have considerable resemblance to some form of key.

A paragraph in the introduction to *Species Plantarum* about the essential character of specific names shows that his philosophical views had not changed. A later paragraph dealing with *trivial names* says that these have been placed in the margins—a single word for a labyrinth. The trivial name is what we now call a specific epithet. Linnaeus used them for most species in *Pan Suecicus* in 1749, an academical thesis by N. L. Hesselgren, to avoid long-winded names, but in *Species Plantarum*, four years later, they are used throughout. It is obvious that he intended them to be a convenient way to refer to species. Many of them are the first two words of the specific name, which suggests that in writing or in conversation they gave sufficient indication of the plant referred to. But others are entirely new, which does away with the suggestion that in *Species Plantarum* they were simply marginal keywords. In the Addenda, page 1200, eleven names are listed just as we would write them now.

There is a long list of *Nomina Trivialia* in an Appendix, with no explanation. It is confusing to find that these are all old generic names and several botanists, including myself, have thought that this kind of name was what Linnaeus had in mind. It is often wise to read an author's preface carefully ! The reason

for the list was that at the time of the publication of *Species Plantarum* several of these old generic names were in common use and Linnaeus, adopting them as trivial names, gave the page where these are to be found—another indication that the application of trivial names was deliberate and consistent.

What apparently Linnaeus did not realize at the time was that he had shown most clearly that it was unnecessary for a 'specific name' or epithet to denote any distinguishing character whatever.

TROPICAL FUNGI.—IV. NEW SPECIES AND REVISIONS

By C. G. Hansford, M.A., Sc.D., F.L.S.

This paper is a continuation of No. III of this series, published in *Proc. Linn. Soc. Lond.*, **160,** 116–153, 1948, and deals with species found in collections forwarded to me from the Botanical Department of the State Museum of Natural History, Stockholm. The numbering of species is continued from the previous paper mentioned.

197. Irene araliae (Spreng.) Stevens in *Ann. Myc.*, **24,** 425, 1926.

The type collection of *Amphitrichum araliae* Spreng. was collected on *Aralia*, Porto Rico and has the following characters :—

Colonies hypophyllous, black, dense, smooth, 1–3 mm. diam. Mycelium of sub-straight dark brown hyphae 7–9 μ thick, the cells mostly 20–30 μ long, branching opposite at 45–60°, closely reticulate. Capitate hyphopodia alternate or about 5 per cent opposite, somewhat antrorse, straight or bent, 20–32 μ long ; stalk cell cylindric 4–12 μ long ; head cell piriform to irregular, rarely entire, usually angulose to irregularly sub-lobed, very variable in shape and size, 12–22 × 12–17 μ. Mucronate hyphopodia scattered, ampulliform, bent, 15–20 × 7–9 μ, the neck upcurved, 3 μ thick. No mycelial setae. Perithecia scattered, 200–230 μ diam., black, globose, verrucose, each with 4–8 cells growing out into larviform appendages, the other cells bluntly conoid ; appendages cylindric, straight below and pale translucent brownish, gradually attenuate to the bent dark brown obtuse apex, smooth or indistinctly asperulate, thin-walled, indistinctly transversely striate, up to 90 × 18–23 μ thick at the base. Spores wide ellipsoid, dark brown, 4-septate, slightly constricted, 38–48 × 18–22 μ.

198. Irenopsis aciculosa (Wint.) Stevens in *Ann. Myc.*, **25,** 438, 1927.

The type specimen was collected by Moller in San Thomé, West Africa ; and Stevens records it as being on Cucurbitaceae, but this has now been corrected to *Sida carpinifolia*. The Stockholm portion of the type collection corresponds exactly to Deighton's description in *Mycol. Paper*, **9,** C.M.I., Kew, 9, 1944.

199. Irenopsis berggrenii Hansford, sp. nov.

Plagulae hypophyllae vel amphigenae, dispersae, atrae, orbiculares, 1–3 mm. diam., densae, leves. *Mycelium* ex hyphis subrectis vel leniter sinuosis, atrobrunneis, 8–9 μ crassis (cellulis plerumque 15–25 μ longis), opposite ramosis (60–90°), dense reticulatis compositum. *Hyphopodia capitata* alternata vel 1 per centum opposita, 14–30 μ longa ; cellula basali recta vel curvata, cylindracea, 4–16 μ longa ; cellula apicali late ovata, piriformi vel cylindraceo-clavata, saepe curvata, integra, rotundato-angulosa vel sublobata, 10–18 ×

8–12 μ. *Hyphopodia mucronata* in hyphis distinctis evoluta, opposita vel alternata, ampullacea, curvata, 15–20 × 7–10 μ. *Setae myceliales* nullae. *Perithecia* subaggregata, atra, globosa, leniter verrucosa, usque ad 250 μ diam., cellulis rotundato-convexis ; setae peritheciales 10–30, erecto-patentes, dilute brunneae, subtiliter 1–2-septatae, leves, usque ad 100 × 7–10 μ, apice simplices, obtusae vel varie contortae. *Sporae* atrobrunneae, subellipsoideae, utrinque rotundatae, 3-septatae, leniter constrictae, 38–43 × 12–14 μ.

Hab. in phyllodiis *Acaciae* spec. (? *A. melanoxylon*), Melbourne, Australia, *Berggren 381*, 1875.

Hitherto this species is not represented among the Australian collections I have seen, and apparently has not been collected since 1875. I am indebted to Mrs. E. L. Robertson of the Waite Agricultural Research Station, Adelaide, for the determination of the host.

200. Irenopsis bignoniacearum Stevens in *Ann. Myc.*, **24,** 442, 1926.

On *Anemopaegma prostratum*, San Paulo, Brazil, *Usteri 19 ;* on Bignoniaceae indet., Avenida Paulista, San Paulo, Brazil, *Usteri 24 and 25*. The first of these specimens has the following characters :—

Colonies epiphyllous, thin, smooth, black, up to 1 mm. diam., but usually confluent and effuse over the leaf. Mycelium composed of slightly sinuous dark brown hyphae 6–7 μ thick, the cells mostly 20–30 μ long, branching usually opposite at wide angles, loosely reticulate. Capitate hyphopodia alternate, antrorse, 15–18 μ long ; stalk cell cylindric 3–5 μ long ; head cell entire, subglobose, 11–14 × 10–13 μ. Mucronate hyphopodia on a few separate hyphae but there mixed with capitate hyphopodia, opposite or alternate, ampulliform with rather short bent neck. Mycelial setae none. Perithecia loosely scattered, each on a loosely radiate disc of hyphopodiate hyphae extending to 200 μ long, black, globose, slightly verrucose, up to 170 μ diam., with 0–6 erect-spreading setae arising from the upper half ; setae continuous, up to 70 μ long, 7–8 μ thick at the apex, slightly narrower below, the apex obtusely rounded, bent to uncinate or rarely somewhat coiled. Spores dark brown, cylindric to ellipsoid with rounded ends, 4-septate, slightly constricted, 30–37 × 14–17 μ.

201. **Irenopsis paulensis** Hansford, sp. nov.

Plagulae epiphyllae, tenues, atrae, minutae, numerosae, late confluentes. *Mycelium* ex hyphis atrobrunneis, subrectis vel sinuosis, 6–8 μ crassis (cellulis plerumque 25–35 μ longis), opposite vel irregulariter ramosis, laxe reticulatis compositum. *Hyphopodia capitata* alternata, 14–23 μ longa ; cellula basali cylindracea, 2–8 μ longa ; cellula apicali globosa vel late clavata, integra, 11–14 × 11–15 μ. *Hyphopodia mucronata* inter hyphopodia capitata in hyphis paucis intermixta, opposita vel alternata, ampullacea, collo brevi angusto. *Setae myceliales* nullae. *Perithecia* laxe dispersa, atra, globosa, verrucosa, usque ad 170 μ diam. (cellulis conicis usque ad 15 μ altis) superne setis 0–8 ornata ; setae erecto-patentes, subrectae, simplices, obtusae, continuae, dilute brunneae, leves, usque ad 90 × 6–7 μ. *Sporae* atrobrunneae, cylindraceae, utrinque obtusae, 4-septatae, leniter constrictae, 35–40 × 14–16 μ.

Hab. in foliis *Acalyphae* spec., San Paulo, Brazil, *Usteri 22* Typus ; loc. cit., *Usteri 44*.

202. Irenopsis tourloidea Stevens in *Ann. Myc.*, **24,** 441, 1926.

On *Cassia hoffmannseggiana*, Para, Brazil, May 1908, *Baker* in *Rehm. Ascomycetes no. 1793* ; also *Baker 362*, apparently part of the same collection.

The perithecia bear 0–6 erect setae from the upper half, up to 55 μ long with the apex obtuse, bent to uncinate or with 1–3 close coils, not septate, smooth, rather thick-walled.

203. Irenina anastomosans (Wint.) Stevens in *Ann. Myc.*, **24,** 456, 1926.

The type collection was made by Moller in 1885 in San Thome, West Africa and the Stockholm portion has the following characters :—

Colonies epiphyllous, closely scattered and sometimes widely confluent, 1 mm. diam., smooth. Mycelium of dark brown crooked hyphae 7–8 μ thick, the cells mostly 10–20 μ long, branching alternate or unilateral, rarely opposite, at about 60°, loosely reticulate with rounded meshes. Capitate hyphopodia alternate, more or less antrorse, but often at wide angles, usually straight, 15–25 μ long ; stalk cell cylindric-cuneate, 3–10 μ long ; head cell ovate, entire, to piriform, 12–16 × 10–13 μ. Mucronate hyphopodia scattered amongst the capitate, opposite or alternate, ampulliform, 12–18 × 7–10 μ, more or less bent, the neck up-curved, short, 3–4 μ thick. Mycelial setae none. Perithecia in a central group, black, globose, up to 150 μ diam., the surface cells rounded convex, scarcely projecting. Spores dark brown, cylindric with rounded ends, 4-septate, smooth, 28–33 × 12–14 μ. On leaves of Labiatae indet.

Stevens 8130, from Porto Rico, the type collection of *Irenina hyptidicola* Stevens, appears to me to be identical with the above, and must be considered synonymous. The collections made in Uganda on Labiatae, and formerly referred by me to *I. hyptidicola* Stev. var. *wombalensis* (Beeli) Stev. also agree with *I. anastomosans* (*Hansford 3393, 1357, 2023,* etc., *Dummer 2843*).

204. Irenina archnoidea (Speg.) Stevens in *Ann. Myc.*, **24,** 456, 1926.

The Stockholm specimen of *Usteri 17* on Bignoniaceae indet., San Paulo, Brazil, 21. 8. 1905, belongs to this species, which has also been recorded on other host families, though in these cases the determinations need checking as they probably refer to other species.

205. *Irene inermis* var. *macilenta* (Wint.) Stevens in *Ann. Myc.*, **24,** 423, 1926.

The host of the type specimen, *Moller,* San Thome, West Africa, has been determined for me by Mr. P. Taylor, Royal Botanic Gardens, Kew, as *Brillantaisia patula* T. Anders. The Herb. Stockholm specimen has the following characters :—

Colonies epiphyllous, rarely also hypophyllous, black, dense, smooth, up to 1 mm. diam., closely scattered but not usually confluent . Mycelium of substraight to slightly sinuous dark brown hyphae 6½–8 μ thick, the cells mostly 15–20 μ long, branching opposite or irregular at 30–60°, closely radiating-reticulate. Capitate hyphopodia alternate, more or less antrorse, usually straight, 14–19 μ long ; stalk cell cylindric-cuneate 3–8 μ long ; head cell ovate, entire, 11–14 × 8–11 μ. Mucronate hyphopodia mixed with capitate in the centre of the colony, opposite or alternate, ampulliform, more or less bent, 14–20 × 6–9 μ, the neck elongate, upturned, 3 μ thick. Mycelial setae none. Perithecia in a close central group, black, globose, verrucose, 120–150 μ diam., the surface cells rounded-convex to obtusely conoid, scarcely projecting. Spores dark brown cylindric with rounded ends, 4-septate, 28–33 × 11–13 μ.

The perithecia have no ' larviform appendages ', so that Stevens was in error in including this form in *Irene*. It is a typical *Irenina* in structure and differs from *I. anastomosans* chiefly in having rather smaller and more ovate capitate hyphopodia, at most it can be considered as a separate variety of that species, as **anastomosans** var. **macilenta** (Wint.) Hansf., comb. nov.

206. **Irenina negeri** Hansford, sp. nov.

Plagulae plerumque epiphyllae, atrae, usque ad 1 mm. diam., vel confluentes, subtenues, leves. *Mycelium* ex hyphis atrobrunneis, undulatis vel flexuosis, 8–10 μ crassis (cellulis plerumque circa 25 μ longis), opposite acuteque ramosis, laxe reticulatis compositum. *Hyphopodia capitata* alternata, plus minusve antrorsa, recta vel curvula, 20–31 μ longa ; cellula basali cylindracea, 5–10 μ longa, cellula apicali late ovata vel clavata, integra, 13–22 × 10–14 μ. *Hypho-*

podia mucronata in hyphis paucis evoluta, opposita vel alternata, breviter ampullacea, collo curvato praedita. *Setae* nullae. *Perithecia* dispersa, atra, globosa, verrucosa, usque ad 320 μ diam., cellulis superficialibus conicis, usque ad 20 μ altis. *Sporae* atrobrunneae, cylindraceae, utrinque rotundatae, 4-septatae, leniter constrictae, 48–54 × 18–21 μ.

Hab. in foliis *Compositarum* spec. indet., Concepcion, Chile, leg. *Neger, Plant. Chilenses 114*, 5, 1896. Typus in Herb. Stockholm.

207. **Irenina Pleurostyliae** (B. & Br.) Hansf., comb. nov.

Asterina pleurostyliae B. & Br., *J. Linn. Soc.* (Bot.), **14**, 132, 1873.
Meliola pleurostyliae (B. & Br.) von Hoehnel, *Fragm. Mykol.*, no. **522**, 1910.
Asterina ditricha Kalchbr. & Cooke, *Grevillea*, **9**, 32, 1880.
Meliola ditricha (Kalchbr. & Cooke) Doidge, *Trans. Soc. S. Afri.*, **5**, 728, 1917.
Irene ditricha (Kalchbr. & Cooke) Doidge, *S. Afr. J. nat. Hist.*, **2**, 41, 1920.
Irenina ditricha (Kalchbr. & Cooke) Stevens, *Ann. Myc.*, **24**, 467, 1926.

The Herb. Stockholm specimen is marked " ex Herb. Berkeley " and is on *Pleurostylia wightii*, Ceylon, apparently being part of the type collection *Thwaites 470*, Peradeniya, Ceylon, Dec. 1867. Comparison with South African specimens shows that these are the same species ; they have been well described by Doidge in *Bothalia*, **2**, 433, 1928 on *Pleurostylia capensis* and *Celastrus* spp.

208. **Irenina singalensis** Hansford, sp. nov.

Plagulae epiphyllae, rarius etiam hypophyllae, atrae, leves, 1 mm. diam. vel confluentes, subdensae. *Mycelium* ex hyphis rectis atrobrunneis, 8–10 μ crassis (cellulis plerumque 25–40 μ longis), opposite ramosis, radiato-reticulatis compositum. *Hyphopodia capitata* alternata, plus minusve antrorsa, subrecta, 25–35 μ longa ; cellula basali cylindracea, 8–15 μ longa ; cellula apicali subglobosa vel piriformi, integra, 16–22 × 12–18 μ. *Hyphopodia mucronata* in centro plagularum in hyphis distinctis evoluta, opposita vel alternata, ampullacea, plus minusve curvata, 25–35 × 9–11 μ, collo elongato 4–5 μ crasso praedita. *Setae* nullae. *Perithecia* dispersa, atra, globosa, verrucosa, 240–300 μ diam., cellulis superficialibus conicis, usque ad 35 μ altis. *Sporae* atrobrunneae, ellipsoideae, 3-septatae, leniter constrictae, 50–58 × 19–23 μ.

Hab. in foliis *Symploci* spec., Ceylon ; typus in Herb. Stockholm.

The surface cells of the perithecia sometimes extend into straight or bent conical processes up to 35 μ high, but these cannot be regarded as larviform appendages. The specimen quoted is " ex Herb. Berkeley " and was labelled " *Meliola Moerenhoutiana* ".

209. Irenina umirayensis (Yates) Hansf. in *Proc. Linn. Soc. Lond.*, **157**, 170, 1946.

On *Ficus nota*, Los Banos, Philippines, *Phil. Bur. Sci. 869*, leg. *C. F. Baker*, in Herb. Stockholm sub " *Meliola ambigua* f. *ficina*, Rehm ".

210. **Irenina usteriana** (Rehm) Hansford, comb. nov.

Meliola usteriana Rehm in *Ann. Myc.*, **5**, 523, 1907.

As noted by me in *Proc. Linn. Soc. Lond.* **160**, 131, 1948, Stevens considered this species as a synonym of *I. longipoda* (Gaill.) Stev. ; I have now examined Rehm's type material in Herb. Stockholm, on *Cordia* sp., San Paulo, Brazil, *Usteri 42* :—

Colonies epiphyllous, closely scattered, numerous, 1–2 mm. diam., becoming confluent, rather dense when mature. Mycelium of dark brown sinuous-radiating hyphae 6–7 μ thick, the cells mostly 20–30 μ long, branching usually

opposite at 45–60°, loosely reticulate, becoming closer in centre of old colonies. Capitate hyphopodia alternate, more or less antrorse, 12–18 μ long, straight, stalk cell cylindric, 3–8 μ long, head cell globose to widely ovate, entire, 10–13 × 9–12 μ. Mucronate hyphopodia few, scattered, or in some colonies on separate hyphae, alternate, opposite or sometimes ternate, ampulliform, usually more or less bent, 15–20 × 7–9 μ, with upturned neck 3 μ thick. Mycelial setae none. Perithecia loosely scattered in centre of colony, black, globose, verrucose, 170–205 μ diam., the surface cells conoid to broadly mammillate. Spores dark brown, oblong with rounded ends, 4-septate, smooth, slightly constricted, 32–3812–15 μ.

Sydow. Fung. exot. exs. 801 on *Cordia heterophylla*, Venezuela, belongs here.

211. **Irenina usterii** Hansford, sp. nov.

Plagulae epiphyllae, subtenues, atrae, usque ad 3 mm. diam., leves. *Mycelium* ex hyphis subrectis, atrobrunneis, 7 μ crassis (cellulis plerumque circa 25 μ longis) opposite ramosis, laxe reticulatis compositum. *Hyphopodia capitata* opposita, recta 13–17 μ longa ; cellula basali cylindracea 3–5 μ longa ; cellula apicali cylindracea, apice rotundata, integra, 9–14 × 6–9 μ. *Hyphopodia mucronata* inter hyphopodia capitata interspersa, opposita vel alternata, ampullacea, curvata, 16–22 × 6–8 μ. *Setae* nullae. *Perithecia* dispersa, atra, globosa, verrucosa, usque ad 260 μ diam., cellulis superficialibus conicis, usque ad 25 μ altis. *Sporae* atrobrunneae, ellipsoideae, 4-sepatate, leniter constrictae, 36–41 × 17–18 μ.

Hab. in foliis *Leguminosarum* spec. indet., San Paulo, Brazil, *Usteri 43*, 23. 7. 1906 ; typus in Herb. Stockholm.

212. Meliola acutiseta Syd., *Leafl. Philippine Bot.*, **6**, 1921, 1913.

On *Persea piriformis*, Philippines, *Phil. Bur. Sci. 13312*.

The Stockholm specimen of the type collection, ex Herb. Sydow, is re-described as follows :—

Colonies hypophyllous, black, circular, thinly velvety, 3–10 mm. diam. Mycelium of substraight dark brown hyphae 5–7 μ thick, the cells mostly 20–30 μ long, branching usually opposite at 45–90°, rather closely reticulate. Capitate hyphopodia opposite or alternate, straight or variously bent, 13–35 μ long ; head cell cylindric, straight or bent, widely rounded at apex, entire, 9–18 × 6–9 μ, rarely irregular in outline through crowding ; stalk cell cylindric, straight or bent, 3–18 μ long. Mucronate hyphopodia very few, opposite or alternate, scattered, ampulliform, 12–18 × 5–7 μ, the neck rather long, upcurved, 3 μ thick. Mycelial setae closely scattered, black, straight, erect, simple, acute, 250–350 × 7–9 μ. Perithecia loosely scattered, black, globose, verrucose, 140–180 μ diam., the surface cells rounded-conic ; the young perithecia on a loosely radiate disc which is hidden when mature. Spores dark brown, cylindric with slightly attenuate-rounded ends, 4-septate, constricted, smooth, 38–44 × 11½–13 μ.

213. Meliola aethiops var. *flexuosa* Hansf. & Deight., *Mycol. Paper*, C.M.I. Kew, **23**, 22, 1948.

On *Bauhinia* sp., Rio de Janeiro, Brazil, Sept. 1908, *Theissen 12*, in Herb. Stockholm.

This specimen represents an extreme divergence from the type of *M. aethiops* in its sinuous mycelium and in the comparative rarity of opposite hyphopodia.

214. Meliola affinis Syd. in *Leafl. Philippine Bot.*, **6**, 1921, 1913.

The Herb. Stockholm specimen of the type collection on *Memecylon urdanetense*, Mindanao, Philippines, *Phil. Bur. Sci. 14114*, has been examined :—

Colonies hypophyllous, greyish-black, very thin, effuse. Mycelium of dark brown substraight hyphae 6–9 μ thick, the cells mostly 30–50 μ long,

branching opposite or irregular at 45–90°, very loosely reticulate. Capitate hyphopodia alternate or more scattered, at wide angles, usually straight but sometimes sub-uncinate, 22–30 μ long ; stalk cell cylindric, usually straight, 6–10 μ long ; head cell cylindric to narrowly ovate, wide rounded at apex, entire, usually more or less bent, 15–25 × 9–12 μ. Mucronate hyphopodia rather few, scattered amongst the capitate, opposite or alternate, narrow ampulliform, more or less bent, 25–35 × 7–10 μ, the neck elongate and upturned, 3–4 μ thick. Mycelial setae grouped around the perithecia, erect, more or less straight, black, some up to 300 μ others up to 750 μ long, all 10–12 μ thick at the base ; mostly 2–4 dentate to 10 μ at the apex, but some simple and obtuse. Perithecia loosely scattered, usually seated on a loosely radiate disc of exhyphopodiate hyphae up to 200 μ long, black, globose, verrucose, 100–200 μ diam., the surface cells obtusely conoid. Spores dark brown, oblong with widely rounded ends, 4-septate, constricted, smooth, 44–51 × 16–20 μ.

214a. Meliola aliena Syd. in *Leafl. Philippine Bot.*, **5**, 1535, 1912.

In Herb. Stockholm are three specimens ex Herb. Sydow : *Phil. Bur. Sci. 12872* (type collection) ; *12586* and *27186*. These have been re-examined :—

Mycelium forming very dense velvety colonies on the host twigs, very closely adherent, up to 8 mm. diam., forming a solid plate of hyphae and hyphopodia, composed of dark brown hyphae 10–12 μ thick, the cells 8–15 μ long ; branching irregular and intricate, even at the edge of the colony. Capitate hyphopodia alternate, usually antrorse, 13–21 μ long ; head cell rounded or angular through crowding, when free globose, 11–17 × 11–15 μ ; stalk cell short cylindric 2–5 μ long. Mucronate hyphopodia not seen. Mycelial setae very numerous, erect, black, straight, simple, subacute, 200–275 × 10–14 μ. Perithecia numerous, black, subglobose verrucose, 130–170 μ diam. Spores dark brown, cylindric to ellipsoid with rounded ends, slightly constricted, 4-septate, 43–48 × 14–17 μ.

215. Meliola anceps Syd. in *Ann. Myc.*, 76, 1916.

Re-described from the Herb. Stockholm specimen of the type collection, *Ule. Herb. brasil. 3441*, ex Herb. Sydow :—

On *Uncaria guyanensis*. Colonies hypophyllous, black, thin, almost smooth, 2–10 mm. diam., or confluent. Mycelium of dark brown substraight hyphae 6–7 μ thick, the cells mostly 25–40 μ long, branching usually opposite at 30–60°, loosely radiating-reticulate. Capitate hyphopodia alternate only, usually straight and somewhat antrorse, 13–20 μ long ; stalk cell cylindric to cuneate, 3–7 μ long, head cell ovate to subglobose, entire, widely rounded at apex, 10–14 × 8–12 μ. Mucronate hyphopodia rather few, mostly on separate hyphae towards the centre of the colony, mixed with a few capitate, opposite or alternate, ampulliform 15–24 × 7–9 μ, the neck bent upwards, 3–4 μ thick. Mycelial setae in small groups around the perithecia, erect, black, straight or slightly bent, 120–250 × 7–9 μ, apex obtuse and sometimes slightly inflated, rarely bifid to 10 μ. Perithecia scattered, black, globose, slightly verrucose, 120–150 μ diam., the surface cells rounded-convex. Spores dark brown, oblong with rounded ends, 4-septate, slightly constricted, smooth, 27–32 × 12–14 μ.

216. Meliola andina Gaill. in *Bull. Soc. myc. Franc.*, **13**, 185, 1892.

On unknown host, Canzanoto, Ecuador, *Lagerheim*, July 1892 ; the Herb. Stockholm specimens are re-described :—

Colonies amphigenous, mostly hypophyllous, black, dense, velvety, up to 5 mm. diam. Mycelium of flexuous dark brown hyphae 7–9 μ thick, the cells mostly 15–20 μ long, branching mostly opposite at wide angles, forming a close network. Capitate hyphopodia alternate or about 2 per cent opposite,

straight, 11–17 μ long ; stalk cell cylindric 2–6 μ long ; head cell globose, 10–13 μ diam. Mucronate hyphopodia few, scattered amongst the capitate, opposite or alternate, ampulliform with short bent neck. Mycelial setae few to numerous, scattered, erect, black, straight, up to 280 × 7–9 μ thick at the base, very short (–8 μ) bifurcate at the apex, the branches spreading and often 2-dentate (–10 μ). Perithecia scattered, black, globose, verrucose, up to 210 μ diam. Spores dark brown, cylindric with rounded ends, 4-septate, constricted, 31–37 × 13–14 μ.

217. Meliola ardisiae Syd., *Leafl. Philippine Bot.*, **9**, 3116, 1925.

On *Ardisia japonica*, Mt. Yokugura, Japan, leg. *Yoshinaga*, November 1901, in Herb. Stockholm as "*M. Ardisiae* P. Henn." which appears to be a *nomen nudum*.

Colonies amphigenous, rounded, black, dense, thinly velvety, up to 2 mm. diam. Mycelium of substraight dark brown hyphae 7–9 μ thick, the cells mostly 20–25 μ long, branching usually opposite at wide angles, forming a close network. Capitate hyphopodia alternate or about 5 per cent opposite, somewhat antrorse, 15–22 μ long ; stalk cell cylindric 3–7 μ long, head cell subglobose, entire, to widely clavate, 12–17 × 10–14 μ. Mucronate hyphopodia few, mixed with the capitate towards the centre of the colony, ampulliform with bent neck. Mycelial setae scattered, erect, straight, black, simple, acute, 400–550 × 8–10 μ thick at the base. Perithecia closely scattered, black, globose, verrucose, up to 180 μ diam. Spores dark brown, ellipsoid, 4-septate, constricted, 48–53 × 19–21 μ.

218. **Meliola bixae** Hansford, sp. nov.

Plagulae amphigenae, plerumque epiphyllae, 1–7 mm. diam. vel late confluentes, tenuiter velutinae. *Mycelium* ex hyphis atrobrunneis, flexuosis, 6 μ crassis (cellulis plerumque circa 30 μ longis), opposite ramosis, subdense reticulatis compositum. *Hyphopodia capitata* opposita vel alternata, recta, 11–17 μ longa ; cellula basali cylindracea, 2–5 μ longa ; cellula apicali cylindracea, apice rotundata, vel subglobosa, integra, 9–13 × 6–8 μ. *Hyphopodia mucronata* subnumerosa, inter hyphopodia capitata interspersa, ampullacea, collo elongato curvato praedita. *Setae myceliales* dispersae, erectae, simplices, obtusae, superne varie flexuosae vel uncinatae, usque ad 310 × 7 μ. *Perithecia* dispersa, atra, globosa verrucosa, usque ad 160 μ diam. *Sporae* atrobrunneae, cylindraceae, utrinque rotundata, 4-septatae, constrictae, 35–42 × 13–17 μ.

Hab. in foliis *Bixae orellanae*, Para, Brazil, *Baker 379*, 12. 5. 1908 ; typus in Herb. Stockholm.

219. Meliola caseariicola Hansf., *Proc. Linn. Soc. Lond.*, **159**, 24, 1947.

On *Casearia guineensis*, San Domingo, *Ciferri 2776* ; on *Casearia* sp., San Leopoldo, Rio Grande do Sul, Brazil, 1908, leg. *Rick ;* ditto, loc. cit., *Theissen, Dec. Fung. Brasil. 292.*

220. **Meliola cassiicola** Hansford, sp. nov.

Plagulae hypophyllae, atrae, velutinae, subdensae, usque ad 6 mm. diam. *Mycelium* ex hyphis atrobrunneis, flexuosis, 6–7 μ crassis (cellulis plerumque 20–25 μ longis), opposite vel irregulariter ramosis, dense reticulatis compositum. *Hyphopodia capitata* alternata, 11–15 μ longa, cellula basali cylindracea, 2–5 μ longa, cellula apicali globosa vel ovata, integra, 9–12 × 7–11 μ. *Hyphopodia mucronata* pauca, dispersa, opposita vel alternata, ampullacea, collo brevi curvato praedita. *Setae myceliales* dispersae, erectae, rectae, atrae, usque ad 250 × 6–7 μ, apice cristato-dentatae (–10 μ). *Perithecia* dispersa, atra, globosa, leniter verrucosa, usque ad 160 μ diam. *Sporae* atrobrunneae, cylindraceae, utrinque rotundatae, 4-septatae, constrictae, 29–33 × 11–12 μ.

Hab. in foliis *Cassiae hoffmannseggianae*, Para. Brazil, *Baker 362*, 12. 5. 1908; typus in Herb. Stockholm.

221. MELIOLA CORALLINA Mont. in Gay, *Hist. Chile*, **7**, 472, 1850.

On *Drimys confertiflora*, Juan Fernandez Island (ex Herb. Montagne in Herb. Stockholm, apparently part of the type specimen, *Bertero 1747*) ; on *Drimys winteri* var. *chilensis*, Valdivia, Chile, leg. *Lechler* (ex Herb. Thuemen in Herb. Stockholm). The determinations of the hosts were made by Mr. N. Y. Sandwith from duplicates in Kew Herbarium.

Colonies hypophyllous, black, circular, rather dense, smooth, 1–4 mm. diam. Mycelium of dark brown hyphae 9–11 μ thick, the cells mostly 20–30 μ long, branching usually opposite at acute angles, rather closely reticulate. Capitate hyphopodia alternate, usually straight and more or less antrorse, 20–30 μ long ; stalk cell cylindric, 4–10 μ long ; head cell subglobose, entire, 15–20 × 12–17 μ. Mucronate hyphopodia on separate hyphae in centre of colony, opposite or alternate, conoid to ampulliform, more or less bent, 15–25 × 7–10 μ, with bent neck 3–4 μ thick. Mycelial setae were not seen in the first specimen quoted above, but in the second are very few, grouped around the perithecia, erect, black, straight, simple obtuse, up to 280 × 10 μ. Perithecia loosely scattered, black, globose, slightly verrucose, up to 280 μ diam., the surface cells broadly rounded-conical, scarcely projecting. Each perithecium is seated on a loose radiate disc of exhyphopodiate hyphae up to 150 μ long. Spores dark brown, oblong to widely ellipsoid, 4-septate constricted, 50–56 × 21–26 μ. In the second specimen a few capitate hyphopodia were found opposite.

A third specimen in Herb. Stockholm, collected by Skottsberg in 1917 on *Drimys winteri*, Juan Fernandez, is heavily parasitized by *Helminthosporium dorycarpum* Mont., and shows no mycelial setae nor ripe perithecia. The capitate hyphopodia are rather larger and more variable in shape than in the other two specimens above, being 22–32 μ long with the head cells subglobose to piriform, sometimes slightly rounded-angulose, sometimes bent, 15–22 × 13–18 μ. The only spore found measured 60 × 26 μ. The specimen is labelled *M. compacta* (Lév.) Speg., which Stevens considered a synonym of *M. corallina*.

222. MELIOLA GNATHONELLA Stev. & Tehon in *Mycologia*, **18**, 16, 1926.

On *Jacaranda* sp., Rio de Janeiro, Brazil, *Ule 1472* ; this specimen differs from description in the absence of a diseased spot and in the presence of occasional setae furcate to 10 μ.

223. MELIOLA IRRADIANS Gaill., *Le Genre Meliola*, p. 92, 1892.

On *Maurya simplicifolia*, Quillota, Chile, part of type collection, *Bertero 1087*, ex Herb. Montagne, in Herb. Stockholm.

Colonies hypophyllous, black, 1 mm. diam., dense, velvety, closely scattered but not usually confluent. Mycelium of sinuous to crooked dark brown hyphae 7–8 μ thick, the cells mostly 15–25 μ long, branching alternate, 30–60°, rarely opposite, closely reticulate. Capitate hyphopodia alternate, mostly more or less antrorse curved, 16–28 μ long ; stalk cell cylindric 5–10 μ long ; head cell ovate to irregularly piriform, straight or bent, sometimes subuncinate, irregularly rounded-angulose to shallowly lobate, versiform, 11–18 × 8–14 μ. Mucronate hyphopodia few, usually on separate hyphae in the centre of the colony, opposite or alternate, ampulliform, 15–22 × 7–8 μ, with short up-curved neck 3–4 μ thick. Mycelial setae numerous, closely scattered, erect, black, simple obtuse, 180–250 × 7–9 μ, variously bent to twisted and more or less hamate in the upper part. Perithecia scattered, black, globose slightly verrucose, 140–180 μ diam., the surface cells bluntly rounded conoid to slightly mammillate. Spores dark brown, cylindric with rounded ends, 4-septate, constricted, smooth, 40–45 × 12–15 μ.

224. Meliola ixorae Yates, *Phil. J. Sci.* (*Bot.*), **12**, 365, 1917.

On *Ixora coccinea*, Ceylon, specimen in Herb. Stockholm ex Herb. Berkeley; parasitized by *Helminthosporium capense* Thuem.

225. **Meliola lithraeae** Hansford, sp. nov.

Plagulae epiphyllae, atrae, densae, subcrustosae, usque ad 2 mm. diam., velutinae. *Mycelium* ex hyphis atrobrunneis, undulatis, 7–8 μ crassis (cellulis plerumque circa 20 μ longis), alternatim ramosis, dense radiato-reticulatis compositum. *Hyphopodia capitata* alternata, antrorsa, recta vel subcurvata, 25–35 μ longa; cellula basali cylindracea, 5–11 μ longa; cellula apicali versiformi, clavata, apice late truncata vel stellatim lobata, 15–27 × 10–22 μ. *Hyphopodia mucronata* non visa. *Setae myceliales* numerosae, erectae, atrae, simplices, obtusae, arcuatae vel flexuosae, apice subuncinatae, usque ad 350 × 9–10 μ, apice circa 5 μ crassae. *Perithecia* dispersa, atra, globosa, verrucosa, usque ad 280 μ diam. *Sporae* atrobrunneae, cylindraceae, utrinque rotundatae, 4-septate, constrictae, 39–46 × 17–19 μ.

In foliis *Lithraeae malleoidis*, Campinas, Brazil, *Noack 683*, Oct. 1897; typus in Herb. Stockholm.

This species is mixed with *M. rhoina* Doidge in this specimen; the mycelium and hyphopodia form almost a solid plate of wavy radiating hyphae.

226. Meliola musae (Kunze) Mont. in *Ann. Sci. Nat.* (2), **20**, 374, 1843.

Herb. Stockholm contains part of the type collection, Weigelt's exs. Surinam, and a second specimen ex Herb. Schweinitz, " on *Pandanus* ", Surinam. Both these collections are represented in Herb. Kew, as well as the following :—

Herb. Berkeley, 1879, " *Meliola musae* Mont., Surinam, ex Herb. Montagne ".

Herb. Berkeley, 1879, " *Meliola curviseta* Lev. on *Heliconia*, Guyana Batava, *Kegel 799* " (? ex Herb. Leveille).

Ule, *Appendix Mycoth, brasil 18*: *Meliola Musae* Mont. on *Ravenala guyanensis*, Amazonas, Manaos, leg. *Ule*.

Mr. E. W. Mason, in forwarding this information on the Kew specimens says that Mr. N. Y. Sandwith has determined the hosts of all these collections as *Ravenala guyanensis* (L. C. Rich.) Benth. (syn. *Urania guyanensis* L. C. Rich.).

Colonies hypophyllous (?), black, thin, up to 10 mm. diam., thinly to densely velvety, sometimes large and effuse. Mycelium of substraight dark brown main hyphae with branches sub-opposite and crooked to meandering, 6–7 μ thick, the cells mostly 25–40 μ long, loosely reticulate. Capitate hyphopodia alternate or up to 5 per cent opposite, up to 100 μ or more long; stalk cell 0–3-septate, cylindric, crooked, 20–90 μ long; head cell ovate to subglobose, usually entire, sometimes elongate and sub-uncinate, 12–20 × 9–12 μ. Mucronate hyphopodia not seen. Mycelial setae numerous, closely scattered, erect, black, simple, obtuse, 220–330 × 7–9 μ, widely arcuate-uncinate in the upper half. Perithecia scattered, black, globose, verrucose, up to 230 μ diam. Spores dark brown, cylindric with rounded ends, 4-septate, constricted, smooth, 43–47 × 13–15 μ.

The species is very characteristic, as there is little distinction between the capitate hyphopodia and the shorter branches of the mycelium save for the presence of the head cell on the former.

227. **Meliola nashii** Hansford, sp. nov.

Plagulae epiphyllae, atrae, densae, usque ad 4 mm. diam. *Mycelium* ex hyphis atrobrunneis, subrectis, 7–9 μ crassis (cellulis plerumque 15–20 μ longis), opposite ramosis (circa 45°), dense reticulatis compositum, in centro plagularum subsolidum. *Hyphopodia capitata* alternata vel usque ad 5 per

centum opposita, antrorsa, 14–19 μ longa ; cellula basali cylindracea, 3–6 μ longa ; cellula apicali globosa, integra, 10–13 × 10–12 μ. *Hyphopodia mucronata* inter hyphopodia capitata interspersa, opposita vel alternata, ampullacea, collo curvato praedita. *Setae myceliales* laxe dispersae, erectae, rectae, atrae, simplices, obtusae vel 2–4-dentate (–7 μ), usque ad 520 × 8–10 μ. *Perithecia* dispersa, atra, globosa, verrucosa, usque ad 180 μ diam. *Sporae* atrobrunneae, ellipsoideae, 4-septatae, leniter constrictae, 45–52 × 20–22 μ.

Hab. in foliis *Magnoliae virginianae*, Eustis, Lake Co., Florida, U.S.A. *Nash, Plants of Florida 1993*, 16. 6. 1895 ; typus in Herb. Stockholm.

228. Meliola osmanthi Syd. in *Ann. Myc.*, **18**, 157, 1920.

On *Osmanthus aquifolius*, Komaba, Tokyo, Japan, 6. 2. 1908.

In this specimen the capitate hyphopodia are alternate only and the setae obtuse to subacute. The spores measure 50–54 × 20–23 μ, from cylindric to ellipsoid in shape. I have not yet seen type material of the species for comparison, so the present determination is provisional.

229. Meliola protii Stevens in *Ann. Myc.*, **25**, 199, 1927.

On *Hedwigia balsamifera*, Porto Rico, ex Herb. Bresadola.

This specimen diverges from Stevens' description mainly in having the mycelial setae up to 560 × 9–11 μ.

230. Meliola psidii Fr. in *Linnaea*, **5**, 549, 1830.

The type collection is on *Psidium pomiferum* and was sent to Fries by Kunze and Rudolphi ; Fries cited as a synonym *Sphaeria trichostroma* Kunze in Weigelt's Exs. 1827. A specimen of this collection is in Herb. Stockholm :—

Colonies hypophyllous, black, velvety, dense, 2–5 mm. diam. Mycelium of dark brown crooked hyphae 5–7 μ thick, the cells mostly 20–30 μ long, branching opposite or irregular at wide angles, closely reticulate. Capitate hyphopodia alternate, more or less bent, at wide angles, 15–30 μ long ; stalk cell cylindric, straight or bent, 4–16 μ long ; head cell from straight cylindric with widely rounded apex to irregularly bent and then rounded angulose, to shallowly sub-lobate with often truncate apex, 10–18 × 6–14 μ. Mucronate hyphopodia scattered, rather few, narrowly ampulliform, more or less bent, 20–30 × 6–9 μ, the neck elongate, upcurved, 3–4 μ thick. Mycelial setae numerous, closely scattered, up to 400 × 7–9 μ, gradually attenuate to the acute apex, straight or slightly bent, simple, black, erect. Perithecia closely scattered, black, slightly verrucose, globose, up to 180 μ diam. Spores subellipsoid with attenuate-rounded ends (sub-conoid), dark brown, 4-septate, slightly constricted, 38–46 × 13–15 μ.

A second specimen in Herb. Stockholm is *Ule 1135* on *Psidium guajava*, Brazil. It shows similar mycelial characters to the above, but the spore ends are somewhat variable from rather widely rounded to attenuate-rounded, and the spores measure 35–44 × 14–17 μ.

231. Meliola ramosii Syd. in *Ann. Myc.*, **12**, 552, 1914.

On *Hormonoia riparia*, Los Banos, Philippines, 16. 4. 1914, leg. *Baker, Philippine Bur. Sci. 3141*, in Herb. Stockholm sub "*Meliola ambigua*, f. *hormonoiae* Rehm ".

232. Meliola rhoina Doidge in *Bothalia*, **2**, 454, 1928.

On *Lithraea malleoides*, Campinas, Brazil, *Noack 683*, p.p. ; on *Schinus dependens*, San Leopoldo, Rio Grande do Sul, Brazil, *Rick 150*, p.p. These are the first records of this species occurring outside South and East Africa.

233. Meliola rhois P. Henn. in *Engl. Bot. Jahrb.*, **17**, 523, 1893.

On *Schinus dependens*, San Leopoldo, Rio Grande do Sul, Brazil, *Rick 150*, p.p. ; on *Schinus* sp., loc. cit., *Rick 16*.

234. **Meliola rhois** P. Henn. var. **flexuosiseta** (Speg.) Hansf. comb. nov.
Syn. *Meliola polytricha* var. *flexuosiseta* Speg. in *Rev. Mus. La Plata*, **15**, 16, 1908.

The records of *M. polytricha* Kalchbr. & Cooke on Anacardiaceae are certainly incorrect, and there is little correspondence between it and the form described by Spegazzini on *Schinus* from Brazil. The following specimens have been examined by me :—

On *Schinus terebinthifolius*, Tijuca, Rio de Janeiro, Brazil, *Ule 2268*, April 1897 ; on *S. molle*, San Leopoldo, Rio Grande do Sul, Brazil, *Rick 152* ; on *S. molle*, Porto Allegre, Brazil, *Keissler Krypt. exs. 2211a* ; on *Schinus* sp., Campinas, Brazil, *Noack 761* ; all in Herb. Stockholm. Also in Herb. Inst. Biol. San Paulo, no. 3312, leg. *Rick*, on *Schinus* sp., Santa Maria, Rio Grande do Sul, Brazil.

Colonies epiphyllous, rather dense, black, up to 1 mm. diam. Mycelium of slightly undulate dark brown hyphae 7–8 μ thick, the cells mostly 15–20 μ long, branching usually alternate at acute angles, forming a rather dense network of radiating hyphae. Capitate hyphopodia alternate, 17–28 μ long ; stalk cell antrorsely bent, cylindric, 4–10 μ long ; head cell ovate to cylindric, often rounded-angulose, usually straight, 12–19 × 8–12 μ. Mucronate hyphopodia few to fairly numerous, scattered amongst the capitate or on separate hyphae, mostly alternate, ampulliform with bent neck. Mycelial setae mostly around the perithecia, erect, straight or more often irregularly flexuous, acute or obtuse, simple, up to 300 × 7–9 μ. Perithecia in a loose central group, black, globose, verrucose, up to 280 μ diam. Spores dark brown, cylindric with rounded ends, 4-septate, slightly constricted, 38–44 × 15–18 μ.

235. **Meliola rickii** Hansford, sp. nov.

Plagulae amphigenae, plerumque epiphyllae, orbiculares, atrae, densae, 1–2 mm. diam. *Mycelium* ex hyphis atrobrunneis, subrectis vel leniter sinuosis, 6–8 μ crassis (cellulis plerumque 15–20 μ longis), opposite ramosis, dense reticulatis compositum. *Hyphopodia capitata* opposita vel alternata, recta vel curvata, 13–22 μ longa ; cellula basali cylindracea, 3–6 μ longa ; cellula apicali cylindracea apice late rotundata, saepe curvata, integra, 10–16 × 6–10 μ. *Hyphopodia mucronata* pauca, opposita vel alternata, ampullacea, 16–22 × 7–9 μ, collo curvato, 3 μ crasso praedita. *Setae myceliales* numerosae, atrae, rectae, simplices, 250–320 × 8–9 μ, apice obtusae vel subacutae. *Perithecia* dispersa, atra, globosa, leniter verrucosa, usque ad 175 μ diam., cellulis superficialibus rotundato-convexis. *Sporae* atrobrunneae, cylindraceae, utrinque rotundatae, 4-septatae, constrictae, 34–45 × 14–15 μ.

Hab. in foliis *Meliacearum* spec. indet., San Leopoldo, Rio Grande do Sul, Brazil, Sept. 1905, *Rick 34* ; typus in Herb. Stockholm.

236. Meliola serjaniae Stevens, *Illinois Biol. Monogr.*, **2**, 44, 1916.

On *Serjania* sp., San Leopoldo, Brazil, *Theissen, Decad. Fung. brasil. 7* ; ditto, loc. cit., *Rehm, Ascomycetes 1922, leg. Theissen* ; on *Sapindaceae* indet., loc. cit., *Rick 177* ; ditto, Itajahy, Brazil, *Ule 581* (det. Rehm as *M. parenchymatica* Gaill.).

Of these the first specimen cited has rather larger spores than the others, 42–47 × 16–18 μ as against 35–41 × 15–17 μ ; the Ule specimen has setae only up to 300 μ long.

237. MELIOLA STENOSPORA Wint. in *Hedwigia*, **25**, 97, 1886.

Re-described from the Herb. Stockholm part of the type collection, on *Piper* sp., San Thomé, West Africa, *Moller* :—

Colonies epiphyllous, black, scattered or confluent, thin to subdense, 0·5–2 mm. diam. Mycelium of more or less sinuous dark brown hyphae 6–8 μ thick, the cells mostly 15–25 μ long, branching opposite or irregular at wide angles, loosely to closely reticulate. Capitate hyphopodia alternate, at wide angles, usually straight, 13–22 μ long ; stalk cell cylindric, 3–7 μ long ; head cell usually subglobose with 3–4 rounded angles, sometimes shallowly lobed, 8–15 × 8–14 μ. Mucronate hyphopodia on separate hyphae in centre of colony, opposite or alternate, ampulliform, 12–18 × 7–9 μ, with elongate upcurved neck 3 μ thick. Mycelial setae mostly grouped around the perithecia, erect, black, straight or bent upwards in the lower half, simple, obtuse to acute, up to 400 × 9–12 μ. Perithecia in a close central group, black, globose, slightly verrucose to almost smooth, up to 160 μ diam., the surface cells rounded-convex. Spores dark brown, cylindric with rounded ends, 4-septate, constricted, 33–38 × 10–12 μ.

238. MELIOLA TRISEPTATA B. & Br., ex Cesati, *Atti d. Accad. Sci., fis. Mat.* (8) **4**, 25, 1878.

Dothidea tetradeniae var. *triseptata* B. & Br., in *J. Linn. Soc.* (*Bot.*) **14**, 136, 1873.

The host plant has been identified by Mr. H. K. Airy-Shaw as *Ilex zeylanica* (Hook. f.) Maxim., and I am indebted to Mr. E. W. Mason for providing the above synonomy.

Colonies epiphyllous, black, velvety, dense, 2–4 mm. diam., scattered, not usually confluent. Mycelium of substraight dark brown hyphae 8–9 μ thick, the cells mostly 25–35 μ long, branching opposite at wide angles, closely reticulate and forming a very regular network. Capitate hyphopodia alternate, more or less antrorse, usually straight, 22–32 μ long ; stalk cell cylindric-cuneate, 7–11 μ long ; head cell subglobose to irregularly and shallowly 2–4-lobate, 15–20 × 15–18 μ. Mucronate hyphopodia very few, scattered, opposite or alternate, bent ampulliform, 20–30 × 7–9 μ with elongate upcurved neck 3–4 μ thick. Mycelial setae numerous in most colonies, thickly scattered over the mycelium and also grouped around the perithecia, erect, black, straight or somewhat curved in the lower half, not uncinate, simple, subacute when fully mature, up to 350 × 7–9 μ. Perithecia scattered, black, globose, verrucose, up to 180 μ diam., when young each seated on a loosely radiate disc of exhyphopodiate hyphae. Spores dark brown, narrowly ellipsoid with attenuate-rounded ends, 3-septate, slightly constricted, smooth, 55–63 × 19–22 μ, usually more or less bent.

PROCEEDINGS OF THE ANNIVERSARY MEETING HELD ON 28 May 1953

Lt.-Col. R. B. Seymour Sewell, C.I.E., F.R.S.,
President, in the Chair.

The Proceedings of the General Meeting held on Thursday, 7 May 1953, having been circulated, were taken as read, and confirmed.

The following signed the Obligation in the Roll and Charter Book, and were admitted Fellows :—Mr. Theo Simpson Jones, B.Sc., Mr. Peter Taylor and Mr. Patrick Hazen Forbes White, M.A.

The President reported the deaths of the Lord Aberconway, C.B.E., Fellow, and Dr. R. Lloyd Praeger, Associate *honoris causa.*

Candidates for membership were balloted for and elected :—

Fellows.—Leslie Bilton, M.Sc., Stephen Benjamin Challen, B.Pharm., B.Sc., Mrs. Shyamala Chitaley, M.Sc., David Charles McClintock, M.A. and Miss Effie Moira Rosser, B.Sc., Ph.D.

Foreign Members.—Professor Albert Dalcq, Professor Roger-Jean Heim and Professor Alfred Sherwood Romer.

Associates honoris causa.—Robert Mackechnie and Douglas Miller Reid.

The Bye-Laws regulating the Election of Council and Officers having been read by the General Secretary, the President declared the Ballot for new Members of Council to be open, and voting began. The President thereafter appointed Mrs. Vera Higgins, Mr. R. H. Jeffers and Dr. J. Hutchinson, F.R.S., as Scrutineers of the Ballot.

The Ballot was closed at the due time, and the result declared to the Meeting.—New Members of Council.—Mr. J. S. L. Gilmour, Professor C. T. Ingold, Dr. L. Harrison Matthews, Dr. C. R. Metcalfe and Professor J. E. Smith.

The retiring Councillors were Dr. S. E. Chandler, O.B.E., Professor F. E. Fritsch, F.R.S., Dr. I. Gordon, Mr. C. C. Hentschell and Mr. C. E. Hubbard.

The President declared the Ballot of Officers to be open and voting began. The Ballot was closed at the due time, and the result declared to the Meeting.—Officers.—*President :* Lt.-Col. R. B. Seymour Sewell, C.I.E., F.R.S. ; *Treasurer :* Colonel F. C. Stern, O.B.E., M.C. ; *Zoological Secretary* : Dr. A. Tindell Hopwood ; *Botanical Secretary :* Dr. George Taylor.

THE PRESIDENT'S REVIEW

This Meeting brings to an end the 165th Session of this Society.

During the past year Her Majesty Queen Elizabeth the Second has been graciously pleased to grant Her Patronage to the Society and an Address was sent to Her Majesty expressing our Loyalty and Devotion and our deep appreciation of the honour that she has conferred upon us by consenting to

continue the practice of her Predecessors and become our Patron. We have suffered a great loss by the death of our beloved Queen Mary, who was our senior Lady Honorary Member and who had been graciously pleased to accept this appointment as long ago as 1927.

We deplore the death of two of our Foreign Members, Dr. François Gagnepain, elected in 1946, and Professor Douglas Houghton Campbell, elected as long ago as 1896. We also have to deplore the death of several distinguished Fellows of the Society. Among these are Dr. W. T. Calman, C.B., F.R.S., and Professor F. E. Weiss, F.R.S., both of whom gave many years' service to the Society; both were Past Presidents and had been recipients of the Linnean Gold Medal; Professor G. D. Hale Carpenter, M.B.E., who twice served on the Council and was Vice-President in 1935; Professor Sir Frederick Keeble, C.B.E., F.R.S., who served on the Council 1912–14; Professor J. H. Orton, F.R.S., and Lord Aberconway who served on the Council 1933–36 and was Vice-President, 1933–34.

During the past Session we have had a series of very interesting papers and discussions. At several of these meetings the communications were illustrated by colour-slides and films, among these special mention should be made of :—

1. Miss Katharine Tousey's presentation of the film on "Audubon's America", that has been assembled by the Massachussetts Audubon Society to celebrate the Centenary of the death of John James Audubon, a Fellow of this Society;

2. Dr. E. Schelpe's account of the "Vegetation in the Kangra Himalaya";

3. Mr. Frank L. Hill's talk on "The Natural History of the Monte Bello Islands"; and

4. Dr. William Sladen's account of "The Falkland Islands and the Antarctic".

We have also held four Symposia, two of which dealt with the problem of "The Distribution of Plants and Animals in Africa" and "The Fauna and Flora of the African Mountains and the Ecology of Kilimanjaro" respectively. To the first of these a whole day was devoted and in order to comply with our Bye-laws, our Meeting that was held on 8 January, instead of being closed was adjourned till 29 January and was reopened on that day at 10.30 a.m. Other Symposia dealt with "The Classification of the Fungi" and "The Nature Conservancy".

Other papers read during the Session, and to each of which a whole evening was devoted, dealt with—

"The Behaviour of the chief Jute-Substitute Plants", by Mr. A. E. Haarer.

"Some primary aspects of Classification", by Dr. A. Tindell Hopwood, and

"The Structure, Habits and Evolution of Millepedes", by Dr. S. M. Manton.

The President's Reception was held on 4 December, and nearly 300 Fellows and guests attended. The exhibits were of the usual high order; special mention must be made of Professor Hewer's most interesting film of "Atlantic Seals on Ramsey Island", and the most interesting commentary that he gave with it. Our very sincere thanks are due to all whose who contributed towards a very successful and enjoyable evening.

As reported at our last Anniversary Meeting, your Council, in order to facilitate consultation and examination of specimens in the Linnaean Collections, had proposed the appointment of Honorary Curators. In order to permit of specimens being taken for examination out of the Society's Rooms under efficient safeguards it was necessary to alter certain of our Bye-laws. The proposed new Bye-laws were read at Meetings on 19 February and 5 March and were balloted for and adopted by the Society at its meeting on 19 March; Mr. N. Y. Sandwith and Mr. W. H. T. Tams were then formally appointed Curators of the Linnaean Collections.

As announced at our last Anniversary Meeting, steps were being taken, in conjunction with the Royal Society, the Royal Geographical Society and the Zoological Society, to place a plaque on the house in Broadstone, Dorset, that was occupied by Alfred Russell Wallace, O.M., F.R.S., until his death. A local builder has very kindly offered to affix the Memorial Plaque in place free of charge, and the Ceremony of its unveiling will take place on 1 July at 3 p.m., this being the 95th Anniversary of the Meeting of this Society at which Wallace's and Charles Darwin's epoch-making communications on Evolution were read.

As your President I was invited to attend, as a Member of the Welcoming Committee, the opening Session of the XIIIth International Horticultural Congress that was held in London under the auspices of the Royal Horticultural Society. I also attended the Meeting of the Pharmaceutical Society of Great Britain at which their Hanbury Gold Medal was awarded to Dr. Ednam of Sweden. It may interest Members to know that this Medal was founded by the Pharmaceutical Society in memory of Daniel Hanbury, who was Treasurer of this Society between 1873 and 1875 ; and I had the honour of being asked to second the Vote of Thanks to the Recipient after he had given his Address. Professor A. J. Grove was nominated by the Council to represent the Society at the opening of the Hatherly Biological Laboratories of the University College of the South West at Exeter on 23 April.

Your Council have nominated Dr. Isabella Gordon and Dr. A. Tindell Hopwood to represent the Society at the International Congress of Zoology that is to be held in Copenhagen in August ; and they have very kindly invited me to represent you at the XIIth International Limnological Congress to be held in Cambridge.

As regards our Publications, during the year three parts of the *Proceedings* two parts of the *Journal, Zoology,* and one of *Botany* have been issued and a further part of the *Proceedings* and of the *Journal, Botany,* will be issued shortly.

In conclusion and to turn to more homely matters, during the year the Meeting Room, Office and Ladies' Cloakroom have been redecorated, the lighting in the Council Room greatly improved and a new Carpet has been provided in the Library.

TREASURER'S REPORT

Printed copies of the Accounts for the financial year which ended on 30 April 1953 are before you. For comparison, the figures for last year are printed in italics on the left-hand side. A statement has been prepared by the Auditors who certify as to details ; the Audit Committee has inspected the books, verified the investments and bank balances and passed the accounts ; the action of the Committee has been confirmed by the Council.

I will briefly go through the accounts and deal with the main items :—

On the Income side :—

The Annual Contributions are higher than last year due to an increase in the Fellowship.

Annual Contributions under Deeds of Covenant :—

It will be seen that we received £217 in refund of Income Tax on Deeds of Covenant, and it is hoped that this may be slightly increased next year. It is very much to be hoped that as many Fellows as possible will sign this Covenant which will make no difference to their income but will make a great difference to the income of the Society. Deeds of Covenant can be obtained from the General Secretary.

The Sales of Publications are considerably up on last year, the reason for this being that more publications have been issued this year. We hope to do well next year as we have already outstanding orders for £200.

The Society received through the Royal Society the sum of £1,250 from the Parliamentary-grant-in-aid for Publications. We are deeply grateful for this help to our funds for expenditure on Publications.

The Auckland University have made a grant of £500 towards the cost of printing in our *Journal, Botany,* Professor V. J. Chapman's, F.L.S., paper on New Zealand Algae, and Dr. Hugh Scott, F.R.S., F.L.S., has contributed £293 towards the cost of printing his Gughé Highland paper in the *Proceedings*. Dr. Hugh Scott also paid the cost of the illustrations.

The Society has paid the whole of the cost of publications up to date which includes all those publications which have been issued this year or will be issued in the near future. It has, therefore, been necessary to draw £746 from the Publications Reserve Fund, leaving the Reserve Fund at £1,497. To this must be added £500 from the Auckland University College, £293 from Dr. Hugh Scott, and £200 from the surplus income of last year, which now makes the reserve fund stand at £2,490.

On the Payment side :—

Coal and Electric Current and Gas have cost more.

Repairs are again high owing to the redecoration of the Meeting Room, Old Council Room and Ladies' Room and the installation of improved lighting in the Old Council Room.

Miscellaneous Printing and Stationery is somewhat down, but last year this item covered a period of 18 months.

The Cost of Publications has gone up by £900 owing to the increased number of publications that have been issued during this year.

Salaries, Wages and Pension is much the same as last year. *Staff Annuities* are down due to changes in staff.

Library Account :—

The Account has a balance of £199 after paying the usual items.

Library Restoration Fund :—

This Fund now has a Balance of £869 out of £3,400 which has been subscribed. The Binding and Repairs to books since first it was formed, amount to about £1,367, the purchase of foreign works that were missing in our sets, £374, and extra shelving has cost £610. This year we have spent £183 on a new carpet for the Library.

The Society has received only £16 10*s*. towards this fund this year, and I should like again to appeal to all friends of the Linnean Library to help this

Fund in any way they can by donations or by legacies, in order that this historic and valuable Library can be maintained and conserved, as it should be. Since closing these accounts we have received £100 in memory of a deceased Fellow of the Society.

Trust and Reserve Funds :—

I have already mentioned the Publication Reserve, and there is no more to report on the Trust and Reserve Funds.

Investments :—

No new Investments have been made this year, but £144 Composition Fees received has been invested since the close of the accounts.

I should like to thank our General Secretary, Mr. O'Grady and our Clerk, Mrs. Ziegler, for the excellent manner in which the accounts have been kept, and for the conscientious way in which the work has been done.

If any Fellow wishes to ask any questions on these accounts, I will do my best to answer them.

On a motion by Dr. W. E. Swinton, seconded by Dr. S. E. Chandler, O.B.E., the Report and Statement of Accounts were adopted.

Special Accounts
(Trust and Reserve Funds)

Receipts	£	s.	d.	£	s.	d.
To Balance at 1 May 1952 :—						
Westwood Fund	136	7	10			
Trail Award Fund	25	19	0			
Crisp Award Fund	27	18	1			
Hooker Lecture Fund	152	17	8			
Goodenough Fund	26	6	0			
Minchin Fellowship Fund	13	10	5			
Carnegie Corporation Grant	419	3	7			
Reserve for Publications Fund	2243	9	5			
Deposit (Dr. A. H. Uggla)	15	0	0			
				3060	12	0
,, Transfer from Reserve for Publications Fund				993	0	11
,, Interest on Investments (including Income Tax recovered) :—						
Westwood Fund	10	17	4			
Trail Award Fund	3	11	6			
Crisp Award Fund	13	19	0			
Hooker Lecture Fund	21	18	0			
Goodenough Fund	8	12	8			
Minchin Fellowship Fund	3	0	0			
Staff Pension Fund	9	3	10			
				71	2	4
				£4124	15	3

Payments	£	s.	d.	£	s.	d.
By Reserve for Publications Fund :—						
Transfer to General Account				746	5	1
,, Staff Pension Fund :—						
Purchase of £9 19*s.* 2*d.* 3 per cent Savings Bonds 1955–65				9	3	10
,, Balance at 30 April 1953 :—						
Westwood Fund	£147	5	2			
Trail Award Fund	29	10	6			
Crisp Award Fund	41	17	1			
Hooker Lecture Fund	174	15	8			
Goodenough Fund	34	18	8			
Minchin Fellowship Fund	16	10	5			
Carnegie Corporation Grant	419	3	7			
Reserve for Publications Fund	2490	5	3			
Dr. A. H. Uggla (Deposit)	15	0	0			
				*3369	6	4
				£4124	15	3

* Including £3362 11*s.* 2*d.* in Post Office Savings Bank.

(Presented at the Anniversary

Receipts and Payments of the Linnean Society

General

1951–52 £	RECEIPTS	£ s. d.	1952–53 £ s. d.
	To Balance at 1 May 1952 :—		
	Current Account at Bank	8 8 11	
	Deposit Account Post Office Savings Bank	476 12 8	
	Cash in hand	5 17 0	
	Awaiting Investment	24 0 0	
690			514 18 7
108	,, Admission Fees		80 0 0
	,, Arrears of Annual Contributions	57 16 0	
	,, Annual Contributions for year	2725 19 0	
	in advance	73 5 2	
2837			2857 0 2
22	of Associates		25 1 0
	,, Inland Revenue on Deeds of Covenant		217 5 0
76	,, Composition Fees		80 0 0
342	,, Interest on Investments (including Income Tax recovered)		366 19 2
123	Post Office Savings Bank Account		117 9 4
	,, Sales of Publications :—		
	Transactions	128 6 7	
	Journals	245 18 0	
	Proceedings, &c.	201 1 0	
367			575 5 7
	,, Grants in aid of Publications :—		
750	Royal Society	1250 0 0	
5	*Dr. S. M. Manton*	....	
	Dr. C. F. A. Pantin	10 0 0	
	Auckland University	500 0 0	
	Dr. Hugh Scott	293 0 11	
			2053 0 11
31	,, Miscellaneous Receipts		41 10 0
372	,, Transfer from Reserve for Publications Fund		746 5 1
£5723			£7674 14 10

Library

£		£ s. d.
148	To Balance at 1 May 1952	208 17 7
78	,, Interest on Investments (including Income Tax recovered)	78 17 2
10	,, Donation : John Innes Horticultural Institution	10 0 0
300	,, Transfer from General Account	300 0 0
£536		£597 14 9

Library

£		£ s. d.
1195	To Balance at 1 May 1952	1036 7 11
30	,, Donations : Fellows and Friends	16 10 0
£1225		£1052 17 11

Fellows' Postal

£		£ s. d.
50	To Balance at 1 May 1952	50 6 5

YEAR ENDED 30 APRIL 1953

Meeting, 28 May 1953)

from 1 *May* 1952 *to* 30 *April* 1953

Account

1951–52 £	PAYMENTS	£ s. d.	1952–53 £ s. d.
196	By Coal, Electric Current, and Gas		251 1 2
280	„ Repairs : Sundry		422 9 2
90	„ Taxes and Insurance		93 1 2
460	„ Miscellaneous Printing and Stationery		410 12 1
359	„ Petty Expenses and Postages		360 6 4
	„ Publications :—		
	Printing	2215 7 10	
	Distribution	130 15 6	
	Illustrations	113 1 9	
1578			2459 5 1
..	„ Transfer to Reserve for Publications Fund		993 0 11
1595	„ Salaries, Wages and Pension		1520 3 4
15	„ ' Zoological Record ' (Vol. 88) Donation		15 0 0
..	„ William Wright Smith Lecture Fund—Donation		10 0 0
2	„ International Union for Nature Protection—Donation		2 2 0
204	„ Staff Annuities (Annual Premiums)		108 0 0
95	„ *Investment of Compounders' Fees*		....
34	„ Linnean Medal		34 11 8
300	„ Transfer to Library Account		300 0 0
	„ Balance at 30 April 1953 :—		
	Current Account at Bank	214 6 7	
	Deposit Account Post Office Savings Bank	320 12 2	
	Cash in hand	16 3 2	
	Amount awaiting Investment	144 0 0	
515			695 1 11
£5723			£7674 14 10

Account

£		£ s. d.	£ s. d.
198	By Periodicals		206 5 7
35	„ Binding		174 5 6
94	„ Books		17 15 0
	„ Balance at 30 April 1953 :—		
	Current Account	49 8 8	
	Deposit Account Post Office Savings Bank	150 0 0	
209			199 8 8
£536			£597 14 9

Restoration Fund

£		£ s. d.	£ s. d.
	By Carpet for Library		183 6 0
189	„ *Binding and Repairs to Books*		....
	„ Balance at 30 April 1953 : —		
	Current Account at Bank	22 7 5	
	Deposit Account at Bank	30 10 6	
	Deposit Account Post Office Savings Bank	816 14 0	
1036			869 11 11
£1225			£1052 17 11

Account

£		£ s. d.
50	By Balance at 30 April 1953	50 6 5

Investments on 30 *April* 1953

£	s.	d.	*General Account*		*Market Value 30 April 1953.* £	s.	d.
1000	0	0	3½ per cent London County Consolidated Stock 1958–68	@ 94½	945	0	0
1548	8	9	British Transport 3 per cent. Guaranteed Stock 1978–88	@ 82	1269	14	4
109	8	7	3½ per cent. War Loan, 1952 or after	@ 80½	88	1	10
434	8	7	3½ per cent War Loan, 1952 or after	@ 80½	349	14	4
1000	0	0	2½ per cent Defence Bonds	@100	1000	0	0
2199	18	6	4 per cent Australian Stock 1961–64	@ 99½	2188	18	6
200	0	0	3 per cent War Stock 1955–59	@100¼	200	10	0
1139	13	0	3 per cent Savings Bonds 1955–65	@ 95½	1088	7	4
3260	1	3	2½ per cent Consolidated Stock	@ 60½	1972	6	9
176	19	3	3 per cent Savings Bonds 1960–70	@ 89½	158	7	8
274	5	5	3 per cent Treasury Stock	@ 70½	193	7	3
					£9454	8	0

£	s.	d.	*Library Account*		£	s.	d.
471	18	9	British Transport 3 per cent Guaranteed Stock 1978–88 (Bentham Bequest)	@ 82	386	19	9
103	12	5	Surrey County 3 per cent Stock 1961–66 (Wakehurst Bequest)	@ 89	92	4	4
191	12	7	4 per cent Australian Stock 1961–64 (Walker & Morey Bequests)	@ 99½	190	13	5
107	2	1	2½ per cent Consolidated Stock (Stebbing Bequest)	@ 60½	64	16	0
530	0	0	3 per cent Savings Bonds 1960–70 (Tagart Bequest)	@ 89½	474	7	0
1414	7	11	2½ per cent Consolidated Stock (Flintoff Bequest)	@ 60½	855	14	3
					£2064	14	9

£	s.	d.		*Special Accounts*		£	s.	d.
£1063 10 7	232	5	0	Metropolitan Water Board 3 per cent " B " Stock (Westwood Bequest)	@ 76½	177	13	5
	667	14	2	,, ,, (Hooker Lecture Fund)	@ 76½	510	15	10
	163	11	5	,, ,, (Goodenough Fund)	@ 76½	125	2	8
	557	12	1	2½ per cent Consolidated Stock (Crisp Award Fund)	@ 60½	337	7	0
£380 10 6	156	7	2	,, ,, ,, (Westwood Fund)	@ 60½	94	11	11
	74	14	6	,, ,, ,, (Hooker Lecture Fund)	@ 60½	45	4	0
	149	8	10	,, ,, ,, (Goodenough Fund)	@ 60½	90	8	3
	303	19	7	3 per cent Savings Bonds 1955–65 (Staff Pension Fund)	@ 95½	290	6	0
	9	19	2	,, ,, ,, 1955–65 (Staff Pension Fund)	@ 95½	9	10	2
	100	0	0	,, ,, ,, 1960–70 (Minchin Fund)	@ 89½	89	10	0
	102	3	11	3½ per cent War Loan 1952 or after (Trail Award Fund)	@ 80½	82	5	5
				F. C. STERN, *Treasurer.*		£1852	14	8

We have (in conjunction with the Professional Auditors, who certify as to all details) audited the Accounts of the Society for the year ended 30 April 1953 and found them correct. We have verified the Investments and Bank Balances.

21st May 1953.

W. B. KEEN & Co., *Chartered Accountants,*
Finsbury Circus House,
Blomfield Street, London, E.C.2.

H. R. HEWER
VERA HIGGINS
E. W. LANE
C. R. METCALFE
R. B. SEYMOUR SEWELL
GEORGE TAYLOR
} *Audit Committee.*

GENERAL SECRETARY'S REPORT

List of the Society

Since the last Anniversary Meeting the Society has lost 30 members. The detailed statement is as follows :—

1 *Honorary Member by death :*

Her Majesty QUEEN MARY

12 *Fellows by death :*

Lord ABERCONWAY.
Reginald Evelyn Child BEALE.
William Thomas CALMAN.
Walter Mervyn CARNE.
Geoffrey Douglas Hale CARPENTER.
Atulananda DAS.
Sir Frederick William KEEBLE.
Leonard Charles Rudolph MESSEL.
Jame Herbert ORTON.
Royden Samuel WALE.
John Walker WALTON.
Frederick Ernest WEISS.

2 *Foreign Members by death :*

François GAGNEPAIN.
Douglas Houghton CAMPBELL.

2 *Associates* honoris causa *by death :*

Robert Lloyd PRAGER.
Francis RILSTONE.

13 *Fellows by Withdrawal :*

Reginald AKROYD.
William Broadhurst BRIERLEY.
Donald Albert COULT.
Cecil Henry HOOPER.
Norman Sumner JONES.
Sheila Mackenzie LODGE.
Harold George Fisher MACDONALD.
Minnie MOORE.
Robert John PULLEN.
Douglas Miller REID.
Herbert Kenneth Airy SHAW.
Elizabeth Margaret Ewing SYKES.
Hon. Andrew Nicolas Armstrong VANNECK.

During the Session, 38 Fellows, 3 Foreign Members, 2 Associates *honoris causa* and 7 ordinary Associates have been elected. The number of Fellows on the list is 815, with a further 13 Fellows elected but not yet qualified, *Foreign Members* 49, *Associates* honoris causa 24 and ordinary Associates 33 (4 ordinary Associates have been elected Fellows during the Session).

The Library.

Between 1 May 1952 and 30 April 1953, 14 books have been purchased ; 30 books, 129 parts of periodical publications, and 100 reprints have been presented.

During the same period the number of volumes bound was 204, and 106 volumes have been repaired.

The total number of volumes borrowed from the Library was 1,389 (676 by Fellows and Associates and 713 by the National Central Library).

654 signatures were recorded in the Library Visitors' Book.

The Linnaean and Smithian Collections have been consulted on 59 occasions during the Session.

PRESENTATION OF THE LINNEAN MEDAL

In handing the Linnean Gold Medal to Professor P. A. BUXTON, C.M.G., F.R.S., the PRESIDENT spoke as follows :—

Professor Buxton, in awarding you the Linnean Medal for 1953 the Council wishes to honour one whose life has been devoted to researches that would, most assuredly, have been of the greatest interest to Linnaeus himself had he been of our time and generation.

During the war of 1914–18 your studies of the House-fly in Mesopotamia and of the Louse in Persia led to improved hygiene among our troops, and to a remarkable decrease in the incidence of dysentery and relapsing fever. After the war you went to Palestine to investigate the Mosquitoes that carried the malaria parasite and later went to Samoa and the New Hebrides with the same object in view. While there you also devoted much of your time to those species of Mosquito that transmit Elephantiasis, the disease that was, and I fear still is, so familiar to all those who have lived in certain regions of the Tropics.

Your appointment to the Chair of Entomology at the London School of Tropical Medicine and Hygiene gave you an opportunity to impart the fruits of your rich experience to others, but it did not put an end to your voyages of discovery and somehow you found time and opportunity to study plague-carrying Fleas in Palestine, malarial Mosquitoes in the Balkans, India and Ceylon and Tsetse Flies in Nigeria.

When we were again at war in 1939 those responsible for the health of our Forces claimed your services and you were once again in the Near and Middle East fighting your old enemies, the Lice.

It is given to very few to turn their knowledge of Systematics to such good account and by the benefit they bring to their fellows, so to drive home the truth that Taxonomy is the fundamental discipline of Biology.

In handing you this medal, the highest honour that the Society can confer, I can assure you that as one whose active life in a Tropical Country was spent in several capacities, some of which were concerned with the combating of tropical diseases or the prevention of their introduction into a country that up to that time had been free from them, I am deeply conscious of the lasting value of your labours in the laboratory and in the field.

The President announced that he had appointed the following as Vice-Presidents for 1953–54 :—Assistant Professor H. R. Hewer, Professor P. B. Medawar, F.R.S., Mr. E. Milne-Redhead and Colonel F. C. Stern, O.B.E., M.C.

The President then delivered his Address on " A study of the Sea Coast of Southern Arabia ".

On its conclusion, Dr. John Ramsbottom, O.B.E., moved " That the President be thanked for his excellent Address, and that he be requested to allow it to be printed and circulated amongst the Fellows ". The motion was seconded by Assistant Professor H. R. Hewer, and being put to the meeting was carried with acclamation.

Thereafter the President declared the Session of 1952–53 closed.

PRESIDENTIAL ADDRESS

A STUDY OF THE SEA COAST OF SOUTHERN ARABIA.

By Lt.-Col. R. B. Seymour Sewell, C.I.E., Sc.D., F.R.S.

(With 10 text-figures.)

When considering the choice of a subject for my address I was influenced by a Note that was recently submitted by Prof. Louis Fage, of the Oceanographic Institute, Paris, to the International Joint Commission on Oceanography. In this Note he points out that " the data we have in our possession now regarding the density and distribution of the deep-sea benthonic fauna calls for the logical admission that, at least so far as the mud- and detritus-eating animals are concerned, their abundance and their location are largely determined by the content of assimilable organic matter of the sediments " ;

and he points out that " although these sediments in the open sea generally contain a poor fauna they are remarkably populated at certain points ". To explain this profusion of animal life one must study the factors that cause this increase, the most important being the character of the sea-water, not only that which is in contact with the animals on the sea-floor but also the supernatant layers and specially the surface-water, for on the conditions prevailing in the upper levels will depend the quantity and the character of the plankton, and the bulk of the organic matter on the sea-floor must largely be derived from the sinking of the dead bodies of these planktonic organisms (1).

Holme (2) has recently pointed out that as regards shallow-water regions with depths of water of under 70 m. in the Plymouth area, " the biomass is not necessarily related to the quantity of organic matter in a deposit, but seems rather to be related to the suitability of the deposit as a habitat for particular species ", and he gives as an example that shell-gravel of a particular grade may be favourable for the development of a rich fauna of Lamellibranchs and

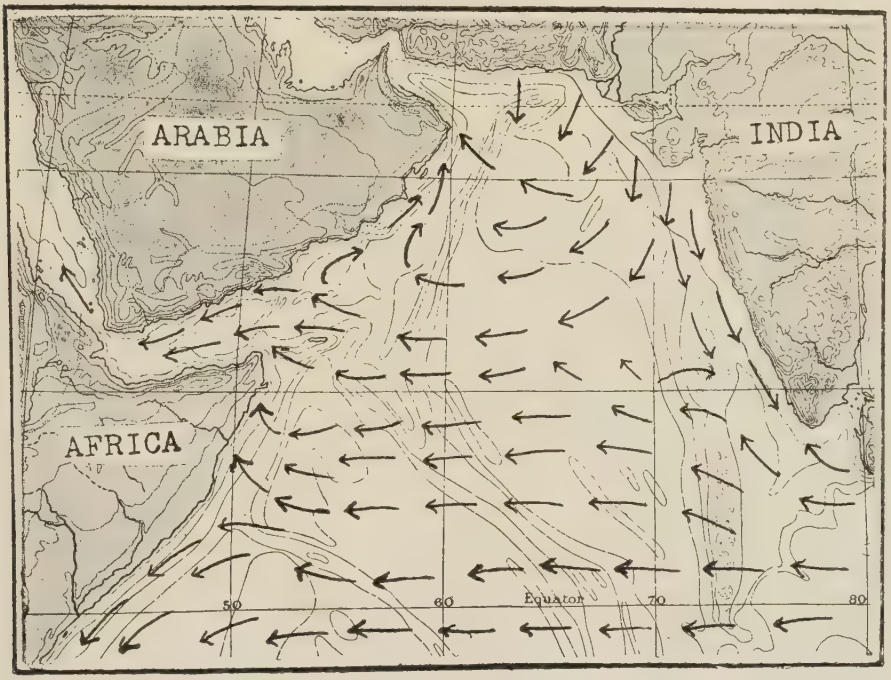

Fig. 1.—The Surface Currents in the Arabian Sea in the month of February.

Amphioxus but, if it be of a different grade, it may be relatively barren. He, however, points out that the density of a benthic species must be affected by fluctuations in the phyto- and zoo-plankton, since this constitutes the food of most species during pelagic life and of suspension feeders in the adult population ; and such fluctuations are closely linked with the supply of nutrient salts.

Carruthers (3) has for some years past emphasized the necessity of studying the influence of the wind on the movements of the water-currents and he has pointed out that " whatever chemical, physical or planktological conditions may be critical in deciding survival prospects (they) will necessarily be in a state of space flux dependent on currents ", and that over the area with which he was concerned " wind rules water to a degree making it difficult to see how

the wind-induced water movements could fail to exert determinative influence on the survival of spawning products". Carruthers was considering the effect of wind on the survival of fish-spawn and the possibility of predicting fluctuations in fish-stocks: but the same principle can be applied more generally, and I propose this evening to attempt to trace the effects that are brought about by a complete reversal of the wind-currents over the region of the northern Indian Ocean that borders the coast of Arabia.

During the work of the 'John Murray' Expedition in 1933–34, we were able to carry out a series of observations, both biological and hydrographical, along the southern coast of Arabia, extending from the Strait of Bab-el-Mandeb on the west to the Strait of Ormuz on the east, and, although our collections have not yet been fully reported on, we have, I think, sufficient evidence to enable us to trace some at least of the effects of this complete change in the direction and force of the wind in different seasons of the year. In addition we have the results of a visit to this area of the R.I.M.S. "Investigator" in 1906, published by the then Surgeon-Naturalist, R. E. Lloyd (4).

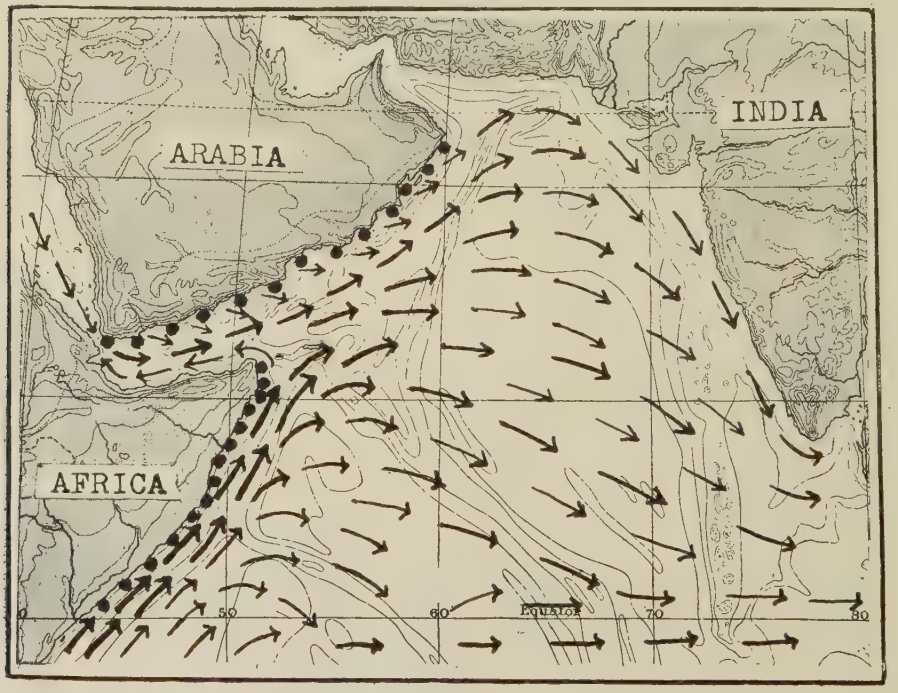

Fig. 2.—The Surface Currents in the Arabian Sea in August and September; showing the area of upwelling water. (After Scott, 1935.)

During the year in the northern part of the Indian Ocean four seasons can be recognized: in the months of December to February the wind along this stretch of coast blows almost continuously from the north-east, i.e. parallel to the Arabian south coast between Ras el-Hadd and Ras Fartak, and the East African coast south of Cape Guarda-fui, constituting the North-east Monsoon: in March to May the winds are variable: from June to August the wind blows with considerable force from the south-west, constituting the South-west Monsoon; and in September to November conditions are again variable. It is now well known that owing to the combined action of the

wind and the effect of rotation of the earth, the surface-water of the ocean in the northern hemisphere will be forced in a direction of about 45 degrees to the right of the wind direction: thus during the North-east Monsoon the surface-water tends to be banked up against the African and Arabian coasts and the general trend of the surface currents in the Arabian Sea is from east to west, the North Equatorial Current being conspicuous in the southern part of the area. During the South-west Monsoon season the North Equatorial Current is completely obliterated and the general trend of the surface-water is from west to east over the greater part of the Arabian Sea, while a strong current, the Somali Current, runs more or less parallel to the coast towards the north-east and there is a well-marked upwelling of water all along the East African and Arabian coasts.

Our observations on the conditions that prevail after the North-east Monsoon in this region were limited to the Gulf of Aden in May; at this time of the year there is clear evidence that the warm, more saline water is banked up against the Arabian coast and Mohamed (5), from his study of the pH values of the water, concludes that "the surface layer is, on the whole, much thicker here, as it extends down to 100 m. at some stations, and the average values of pH within this layer are higher. The lower limit of the phyto-plankton layer has been pushed deeper by the thermocline and the density gradient is not yet steep enough to shut off the supply of nutrient salts". The surface plankton presents the usual tropical character and its density is indicated by the Secchi-disc readings, which were between 31 and 44 m. at the entrance to the Gulf and 26 and 34 m. at its head. A few months later, with the onset of the South-west Monsoon, a great change is brought about along the whole south coast of Arabia. The wind has now completely reversed its direction and by July is blowing strongly from the south-west: this wind now blows the surface-water towards the right and away from the coast, and to take its place cool water wells up from some depth below. This upwelling will vary from year to year both in the time of its appearance and in its extent, depending on the annual variation in the time of onset and the strength of the South-west Monsoon wind. One of the spectacular changes that are brought about is the lowering of the temperature of the surface-water, that at the head of the Gulf causes a fall in the monthly average temperature of from 8°–10° F. at Perim and from 12°–16° F. at Aden between June and August or September: I give below the average monthly temperature of the sea surface-water during the period from 1929–1934.*

At Aden.

°F.

	1929	1930	1931	1932
January	—	89·0	87·2	90·1
February	—	88·2	87·2	87·8
March	—	87·2	88·7	87·3
April	—	88·3	89·6	87·8
May	—	90·0	90·3	89·3
June	89·57	88·7	88·4	90·4
July	83·39	86·8	87·2	—
August	72·71	77·2	81·5	74·8
September ...	78·86	74·9	75·2	76·1
October	86·07	86·8	84·0	80·9
November ...	87·48	86·5	86·2	86·9
December ...	87·53	86·6	89·6	—

*I am much indebted to the Superintendent Engineers of the Condenser Plants at Perim and Aden for very kindly supplying me with the day-to-day recorded temperatures.

At Perim.

	°F.			
	1931	1932	1933	1934
January	—	75·5	78·19	75·9
February	—	75·75	77·76	75·8
March	—	78·0	79·56	77·4
April	—	80·8	83·0	80·6
May	—	84·73	84·64	81·7
June	—	84·0	83·73	83·9
July	78·5	74·5	76·3	75·7
August	69·5	75·2	75·85	76·6
September ...	81·5	78·96	74·7	81·7
October	84·86	84·17	84·2	—
November ...	81·0	81·88	81·04	—
December ...	77·42	78·19	78·10	—

The Monthly Average of the Surface-water Temperature in different years.

On 18 September 1933, as the "Mabahiss" was approaching Perim, the temperature of the sea, recorded at the engine-room 'intake' a few feet below the surface, fell suddenly from 32·5° to 22·5° C. A number of similar observations have been made by Merchant Ships and I am indebted to the Marine Superintendent of the Meteorological Office of the Air Ministry for a number of records. This fall in the surface temperature occurs in a belt along the Arabian and East African coasts; but it appears to be particularly clearly seen near Aden and Perim at the head of the Gulf of Aden and off Cape Guardafui and to the south of Socotra at the entrance. The seaward margin of this cold belt is often quite sharply defined and in some instances temperatures as low as 15·6–16·0° C. have been recorded. This fall in temperature is accompanied by a corresponding fall in salinity of the water and in September 1933, in a traverse across the head of the Gulf of Aden, we obtained the following results:—

Sta.	Latitude N.	Longitude E.	Depth m.	Temperature °C.	Salinity ‰
12	12° 23′ 12″	42° 54′ 48″	0	23·46	36·00
13	12° 12′ 30″	43° 45′ 30″	0	28·27	37·32
14	11° 56′ 00″	43° 38′ 30″	0	30·21	37·70

It appears probable that in certain years this fall in temperature may be destructive of fish-life on a large scale: on 1 September 1931, the S.S. "Modasa" recorded a remarkable fall in the surface temperature, within a few minutes, from 72° F. (22·2° C.) to 60° F. (15·6° C.), and at the same time it was noted that numbers of dead fish were floating on the surface. The ship's position at the time was lat. 10° 00′ N.: long. 51° 20′ E., not far from the African coast and south-west of Socotra. A few days earlier the S.S. "Atreus" had reported a similar drop in the sea temperature and large numbers of dead fish on the surface in the same region. Brongersma-Sanders (6) has recorded that in August, 1944, in the vicinity of Aden "a great mortality of small fish occurred along the 40 miles of coast immediately north-east of Aden". She has reviewed the occurrence of large-scale mortality of fish and other animals of the fauna in regions where upwelling is known to occur and calls attention to the frequency with which this mortality is accompanied by a profuse growth of certain planktonic organisms, such as *Noctiluca*, *Gonyaulax*, *Gymnodinium*, etc., which give rise to a discoloration of the sea that is commonly termed 'Red Water'; and she has concluded that "many cases

of mass mortality are not correctly interpreted in literature, several of them being erroneously ascribed to vulcanism, to the poisonous H_2S or to a sudden change in the salinity and temperature of the sea-water". In a number of instances the mortality is undoubtedly caused by these Protozoa; but in neither of the cases quoted above in this region was there any mention of the occurrence of 'Red Water'. A number of other authors have attributed similar mortality to the effect of the sudden drop in the temperature of the water, that may be brought about either by upwelling (for references to a number of these authors see Brongersma-Sanders, *loc. cit.*, pp. 50, 57), or by an alteration in the course of an ocean current; and the classical instance of such was the destruction of many thousands of specimens of the 'Tile Fish', *Lopholatilus chamaeleonticeps*, off the New England coast of North America in 1879. Other animals beside fish may be similarly affected, namely Crustacea, Mollusca, Polychaeta and Alcyonaria. Stubbings in his account of animal remains in the bottom deposits states that in the Aden area (Area III) the dead shells of a Lamellibranch, which he identified as *Venus torresiana* (Smith), were all of a fairly uniform size in each locality but differed from one locality to another: thus at Sta. 190 the size was small, the valves measuring from 7–8 mm. in length, whereas at Sta. 191, only a little to the west, they were about 13 mm. in length. In both localities the type of bottom deposit was similar, namely green mud and sand, but at the first station the depth was 191 m. and in the second 278 m. He remarks that "the presence of a standard size of shell seems to indicate that the bivalves are in most cases killed off *en masse* by unfavourable conditions rather than by predatory animals. This is borne out by the small number of bored valves, amounting to only about 13·6 per cent of the living animals". Stubbings suggests that a swarm of Asteroids may have been responsible but it seems possible that the destruction of these molluscs may have been due to a sudden change in the temperature of the water caused by upwelling in this region.

It has been stated that in a region such as this the main upwelling commences at about the edge of the continental shelf, where the bottom drops steeply into deep water. Farquharson (7) has shown that in the Gulf of Aden in its middle and eastern parts there is a series of ridges, with deep gullies on their eastern sides, that run out from the Arabian coast in a south-westerly direction, the ridges joining the mainland at a depth of about 1,000 fm. (1,829 m.) (fig. 3). Between the Korya Morya Islands and Ras el-Hadd the approaches to the coast are all very similar in appearance, the depth decreasing very rapidly from 1,000 fm. (1,829 m.) to the 500 fm. (914 m.) line, then more gradually to 250 fm (457 m.), after which it shoals steeply to about 60 fm. (110 m.), which is the average depth of the edge of the continental shelf. A glance at the chart (fig. 4) in which I have plotted the differences in temperature at different depths in the two seasons of the year, viz. September–October and May, clearly indicates that a reduction of the water temperature in the months following the South-West Monsoon can be traced down to a depth of 200 m. and even beyond; thus it would seem that the upwelling current must have its origin on the steep slope between the 457 and 110 m. depths. In September and October the effect of this upwelling is still particularly evident at a depth of 30 and 50 m. By November the cooling effect of the upwelling has practically ceased. A study of the different temperatures recorded at the various depths (*vide* the following table and fig. 4) indicates that the upwelling commences at a depth of about 250 m. and produces its maximum effect at about 30 m. depth. Gilson's estimates of the amount of Nitrate in solution at different depths in this region have shown that the maximum is found at depths of between 150 and 300 m. and it is now well known that an upwelling current will carry into the upper layers an increased quantity of the so-called nutrient salts, nitrates, nitrites, phosphates, etc., which permit of an increase in phyto-plankton productivity,

Locality	Sta.	Month	Depth in metres								
			0	30	50	80	100	150	200	300	400
Off Perim	12	September	—5·59	11·27	10·21	8·31	6·65	3·99	1·65	1·91	1·91
	202	May									
	21	September	+1·49	—7·08	8·10	8·09	7·47	3·24	2·38	2·32	2·36
	198	May									
Off Aden	19	September	+1·57	—8·08	8·22	8·59	7·36	4·38	1·71	0·21	+0·06
	195	May									
Entrance to Gulf of Aden	23	October	—0·40	7·01	7·60	7·71	6·77	4·35	2·89	0·63	0·19
	174	May									
	31	October	—1·17	7·47	6·86	6·99	6·18	3·74	2·27	+1·56	—1·18
	181	May									
	38	October	—1·03	10·03	8·34	6·80	5·05	3·36	1·92	+0·32	—1·19
	182	May									
	32	October	—2·15	6·20	7·47	6·07	4·94	1·63	1·11	0·50	0·53
	183	May									
	30	October	—2·81	7·69	6·91	6·98	6·40	3·57	1·44	0·60	1·38
	175	May									

Differences in Temperature (°C.) of the Sea-water at various depths in the Gulf of Aden between September–October and May.

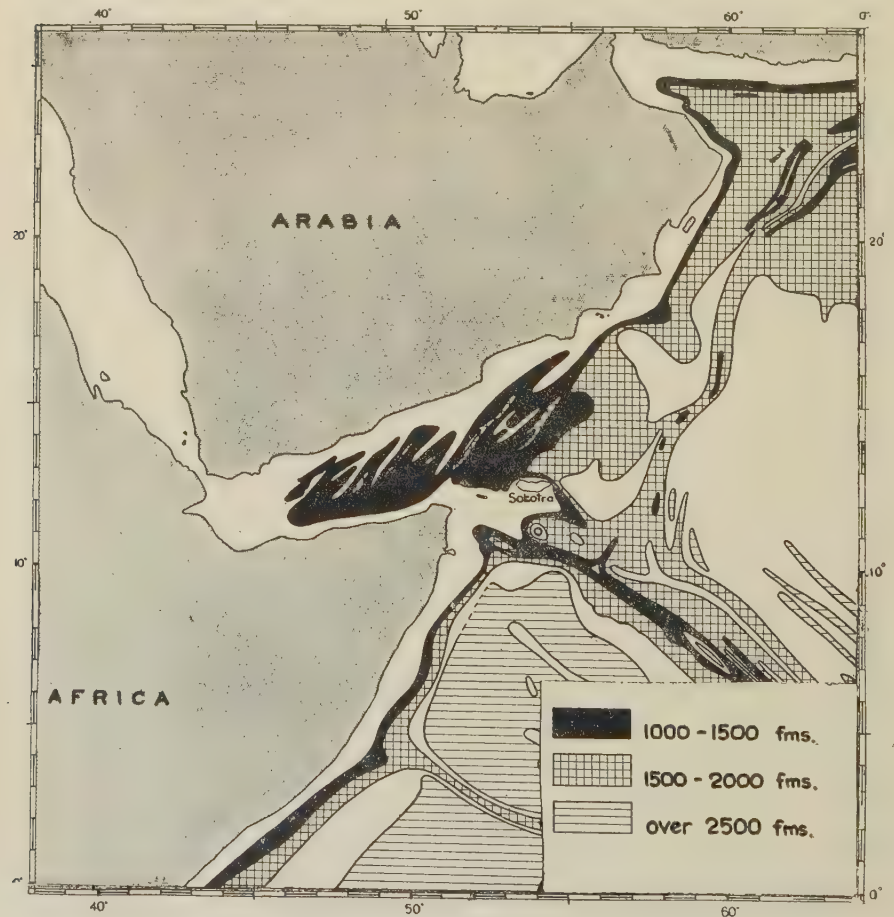

Fig. 3.—Chart of the north-western part of the Arabian Sea. (From the *Marine Observer*, Vol. XII, No. 120 ; October 1935.)

although, as McEwen (8) has pointed out, the associated lowering of the temperature will retard metabolism and so tend to cause a decrease in productivity. But this retarding effect will be of relatively short duration in such a region as the south coast of Arabia, especially in the surface-water, and we should expect to find a great outburst of the phytoplankton soon after the commencement of the South-West Monsoon. Hornell & Nayudu (9) have recorded that off the Malabar coast of South India, the diatom population shows a rapid increase in April–May, following immediately on the onset of the rains and river-floods.

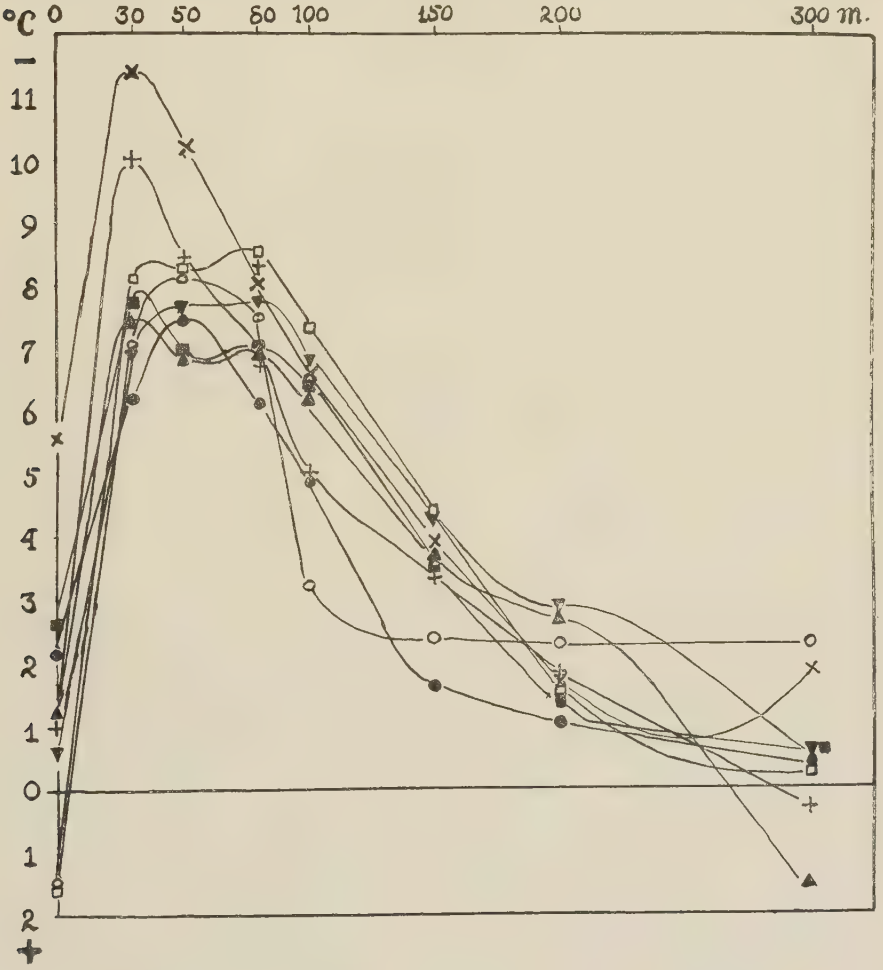

Fig. 4.—Differences in the temperature (°C.) of the sea-water at various depths in the Gulf of Aden between September–October and May.

This fell off in June, when swarms of *Noctiluca* were the most noticeable feature of the plankton: but in July the diatom preponderance was restored and reached its maximum, declining gradually till December. This was followed by a second phase of abundance in January–February, with a fall in March.

Planktonic studies of the surface-water were in general omitted from the programme of the 'John Murray' Expedition, but some observations were carried out in connection with Gilson's studies on the Nitrogen problem and he concluded that by October the "phyto-plankton had already passed its

zenith and was limited by lack of nutrient salts in the productive zone ". Relatively little, if any, work, so far as I know, has been done on the diatoms of the Arabian coastal waters : Karsten (10) has recorded the occurrence of some 90 species from the Gulf of Aden and Subrahmanayan (11) has listed 171 forms, representing 15 Families, 64 Genera and 143 Species, from Indian waters : Mr. Sydney Chaffers, from his studies of certain bottom deposits obtained by the ' John Murray ' Expedition along the Arabian coast, has identified 236 species and varieties, almost all of which are from Sta. 45, depth 38 m., about midway between the Korya Morya Islands and Ras Madraka, and 17 species from two other samples collected at depths of 11 and 29 m. respectively on the north side of the Korya Morya Islands. It would thus appear that the diatom flora of this region is a rich one.

The main outburst of the Phyto-plankton had apparently passed by the time that we reached this area in the middle of September 1933, though there was still a well-marked growth of diatoms that was clearly indicated by the green colour of the coastal water, as contrasted with the deep blue colour of the off-shore water, along the Arabian coast in the neighbourhood of Perim and Aden and round Cape Guarda-fui. The difference in the density of the Plankton in the Gulf and near Cape Guarda-fui in September–October and May is clearly indicated by the Secchi-disc readings taken at the beginning and the end of the expedition, as given below :—

Locality	Stations	September–October	May	Difference	Average
		m.	m.	m.	m.
Head of Gulf of Aden	21, 198	13·5	31·0	17·5	22·3
	12, 202	3·5	26·0	22·5	
	13, 201	8·5	35·5	27·0	
Near Aden	19, 195	23·0	44·0	21·0	12·75
	36, 195	27·0	31·5	4·5	
At entrance to Gulf	23, 174	20·0	28·5	8·5	14·3
	31, 181	9·0	38·0	29·0	
	38, 182	16·5	22·0	5·5	

The Diatom outburst is followed by a profuse development of the Zooplankton and this region is one of the richest that I have encountered. On 8 October, while working at a point off Ghubbet Binna on the African coast to the south of Cape Guarda-fui, large numbers of two species of Medusae were to be seen, namely *Pelagia noctiluca* (Forskål) and *Aurelia maldivensis* Bigelow : on the 25th, in the middle of the entrance to the Gulf, the surface-water was full of plankton, several large examples of a species of Ctenophore (? *Beroe*) were captured and numerous examples of *Porpita* were seen. An attempt was made to count the number of these latter in a belt about 30 feet wide from the ship's side in consecutive periods of four minutes, as the " Mabahiss " steamed on her course ; the numbers thus obtained were 193, 23, 57, 34, 14, 2, and thereafter nil for a short distance, but about a mile farther on another similar patch was found.

Farther along the Arabian coast near the Korya Morya Islands on 28 October and off Ras Madraka on the 31st the plankton was again remarkably rich ; it contained numerous Ctenophores, many Medusae, mostly *Aurelia maldivensis* Bigelow, and a number of the blue pelagic Mollusc *Ianthina*, but the most common component was the Salp, *Pegea confoederata* Forskål, which was present in enormous numbers and in both phases, solitary and aggregated. At times there were as many as 50 examples of the solitary zooid in a square metre at or near the surface, and chains of the aggregated zooid, measuring as much as 3 feet in length, were quite common.

To the east of Ras Madraka and previously off Ras Sukhra, there were still rather faint traces of upwelling, the thermograph in the engine-room in-take showing a fall of 2° to 3°C. below the average of the surface-water, and its

colour was a blue-green. On 4 November the surface was covered with a brick-red scum, the 'Red Water' that Brongersma-Sanders (6) has written about and to which she attributes most, if not all, cases of fish mortality. The colour of the water was due to enormous numbers of a species of *Noctiluca*, but it is interesting to note that there was no sign of any luminescence such as is usually connected with this species, and there were no signs of the death of any fish or other organisms. In addition to *Noctiluca* the surface-water contained numerous examples of the rare Medusa *Crambionella orsini* (Vanhoeffen) Stiasny (12) and many chains of the Salp *Pegea confoederata*. Near the head of the Gulf of Oman and off the Persian coast near Jask there was also a rich plankton and here again the predominant species was the medusa, *Pelagia noctiluca* (Forskål) ; but in addition a number of ephyrae of *Sanderia malayensis* Goette were also taken.

This profuse plankton provides a means of sustenance for a great variety and abundance of other organisms. On 5 November, off Ras al-Hadd, a number of dead squids were seen floating on the surface : all these had been mutilated by some predator, for parts of them had been bitten off : not a single intact specimen was seen. Shoals of fish of various species were common and flying fish were present in large numbers. Large schools of Dolphins were present and on one occasion a couple of Sperm Whales were seen close to the ship.

The presence of this zone of cold water along the coast is largely responsible for the character of the fauna and flora of the littoral zone and causes a superficial resemblance to the shore line of a temperate zone, two outstanding features being (1) a profuse growth in the upper few fathoms along the rocky parts of the coast of species of *Sargassum* weed, fragments and bunches of which break off or are torn off and drift along the coast, and (2) the absence along this coast of any true coral-reefs. In a few places fragments of Madrepore corals such as usually grow in coral reefs are found on the shore as on Soda Island, the most westerly of the Korya Morya group, and near Ras Madraka, and in places the growth of *Lithothamnium* is considerable. Small solitary corals, including several species of the genus *Caryophyllia*, were found in fair numbers, but true reefs are conspicuous by their absence.

The *Sargassum* weed itself provides a home for a number of small animals, and floating bunches of it seem to be specially common in the Gulf of Aden during the months of the North-East Monsoon and immediately after. These clumps harbour a characteristic fauna, very similar to that found in the *Sargassum* weed of the Atlantic Ocean ; some clumps are overgrown by patches of Polyzoa or by small examples of the barnacle, *Lepas anserifera* Linn., and crawling among the fronds are a number of small crabs : other animals hiding in the clumps are several species of fish, such as :—

Petroscirtes ancylodon Rüppell.
Petroscirtes mitratus Rüppell.
Aluterus scriptus (Osbeck).
Diodon holacanthus Linn.
Antennarius sp.
Canthidermis sp.

as well as a Polychaet worm, *Platynereis pulchella* Gravier. Most of these species are protectively coloured to resemble the weed. In addition seven species of Amphipods were obtained from the weed and a number of small Actinians.

Such an abundance of planktonic organisms must provide a constant and profuse rain of dead and decomposing organisms that will eventually sink to the bottom, and as long ago as 1911 Peterson & Boysen Jensen (13) called attention to the importance of " dust-fine detritus " derived from the breaking down of sea-weeds as a source of food for animals living on the sea-floor. Some

idea of the immense number of dead organisms that during the period following the South-West Monsoon are sinking down to the bottom can be gained from a study of a catch that was made at Sta. 61 8–9 November 1933. The main ingredient of the catch was an enormous number of specimens of the Salp, *Thalia democratica* Forskål, and I give below the estimated numbers of zooids taken at different depths in both a day and a night haul :—

Depth	Day Haul		Night Haul	
m.	Solitary	Aggregated	Solitary	Aggregated
500–0	2,700	4,100	—	—
1000–0	2,240	5,200	3,200	3,100
1500–0	840	12,000	280	1,080
2000–0	—	—	600	160

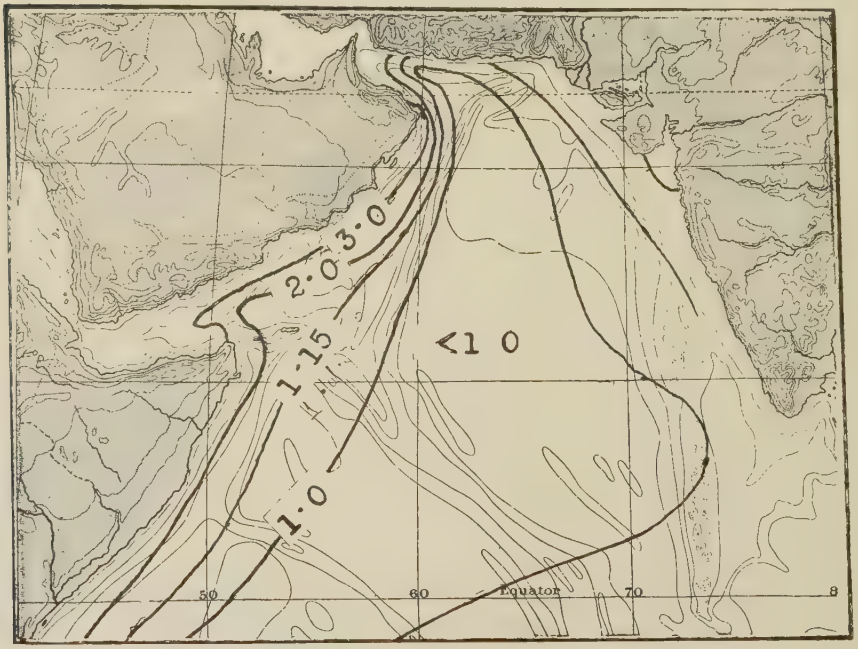

Fig. 5.—The Distribution of Organic Carbon in the bottom deposits of the Arabian Sea. (After Wiseman & Bennett.)

The final destination of such a supply must very largely be dependent on the direction of movement of the sea-water at those depths through which the material has to sink. Matthews (14) has called attention to the direction and character of the surface-currents in the Arabian Sea area and he has shown that between October and December there is a belt of low salinity water that passes along the East African (Somali) coast towards the north and that this can be traced across the entrance to the Gulf of Aden to strike the Arabian coast along a stretch from Ras Fartak westward towards Aden, while in the months June to October this low salinity water reaches the Arabian coast somewhat to the east of Ras Fartak and then sweeps eastward towards Ras el-Hadd. Gilson (15) has also shown that in September 1933 there was a mass of water, rich in nitrate, that sweeps along the coast of Africa till it reaches the Arabian coast and then divides, part moving west along the northern side of the Gulf of Aden between 50 and 1000 m. depth ; this water he ascribes to

deep water from the southern part of the Indian Ocean. It thus seems clear that dead and dying plankton from the surface along this stretch of the African and Arabian coasts, as well as decomposing *Sargassum* weed and the remains of fish, that may have been killed by the change of temperature of the surface-water, will be swept towards the Arabian coast and will finally be deposited along some part of the continental slope, probably below the depth at which the upwelling current begins to be effective, i.e. at about 300–400 or so metres depth.

Wiseman & Bennett (16) have given an account of the actual percentage of organic matter contained in the bottom deposits and have pointed out that this percentage results from three different factors :—

(1) The amount of dead organic matter.
(2) The quantity of organic matter that is deposited, and
(3) The amount of organic matter that is consumed or regenerated before it reaches the bottom.

It will also depend on the quantity of inorganic terrigenous material derived from weathering of the coast that is swept into the sea, but owing to the very small amount of rainfall in this region, this is probably very small. The amount that is deposited will be reduced by the feeding of those carnivores that live on the bottom, by mud-eaters and by bacterial action. They have shown that the whole area possesses a bottom deposit that is relatively rich in organic matter. In fig. 5 I have given a chart (taken from Wiseman & Bennett) showing the percentage of organic carbon in the bottom deposits over the northern part of the Arabian Sea, and in the table below I give the percentage matter in the samples that were taken off the Arabian coast at different depths :

Depth in metres	No. of samples	Averrage percentage of organic matter
Under 100	1	1·83
100– 300	4	4·67
300– 600	2	5·60
600– 900	2	8·15
900–1200	2	6·64
1200–1800	3	4·82
1800–2400	3	3·72
2400–3400	3	1·82

Stubbings (17) has given an account of the biological character of the deposits along this coast and his results show that some components of this deposit, such as fish-remains and the frustules of the larger diatoms such as *Coscinodiscus*, occur principally in two areas, namely off Guarda-fui and in the Gulf of Aden at the western end, and off Ras el-Hadd and in the Gulf of Oman at the eastern end ; and, moreover, are in the main confined to a belt that lies at a depth of between 400 and 800 m. Between the depths of 100 and 400 m. out of 19 samples only five (26 per cent), contained such remains in small numbers ; between the depths of 400 and 800 m. out of ten samples no remains are recorded in three but the other seven (70 per cent) contained large numbers of fish-remains and *Coscinodiscus* frustules, while below 800 m., as far down as 3,289 m. depth, out of 28 stations six (21·5 per cent) contained small numbers and in greater depths below 1,618 m. these remains consisted entirely of *Coscinodiscus* frustules.

Stubbings (*loc. cit.* p. 113) has also pointed out that over the whole area of the Arabian Sea " where the bottom deposit is composed of Green or Brown Mud, a minimum percentage of animal remains is found between 500 and 600 m., below which depth the percentage rises again. This mimimum probably marks the lower limit of the shallow water or littoral fauna and the beginning

of the continental slope fauna, the two exhibiting an ' overlap ' region in which neither is particularly abundant. Below 600 m. the amount of remains present increases considerably to reach a maximum in about 1,100–1,200 m.". He also remarks that " the small amount of animal remains present in the deposit at about 500 m. may be said to be due to the poorness of the fauna in the zone above (the remains will tend to be carried into deeper water) " and he adds " There is a further possible explanation of the minimum value for the amount of animal material at about 600 m. namely the destructive activity of the mud-feeding organisms, which may destroy large numbers of the contained small animals, chiefly Foraminifera ". It seems probable that this last factor is the explanation of the relatively small number of animal remains at depths of about 500 m. in this stretch of coast for, as we shall see when considering the fauna of the different areas, this is particularly rich in the depths between 200 and 400 m.

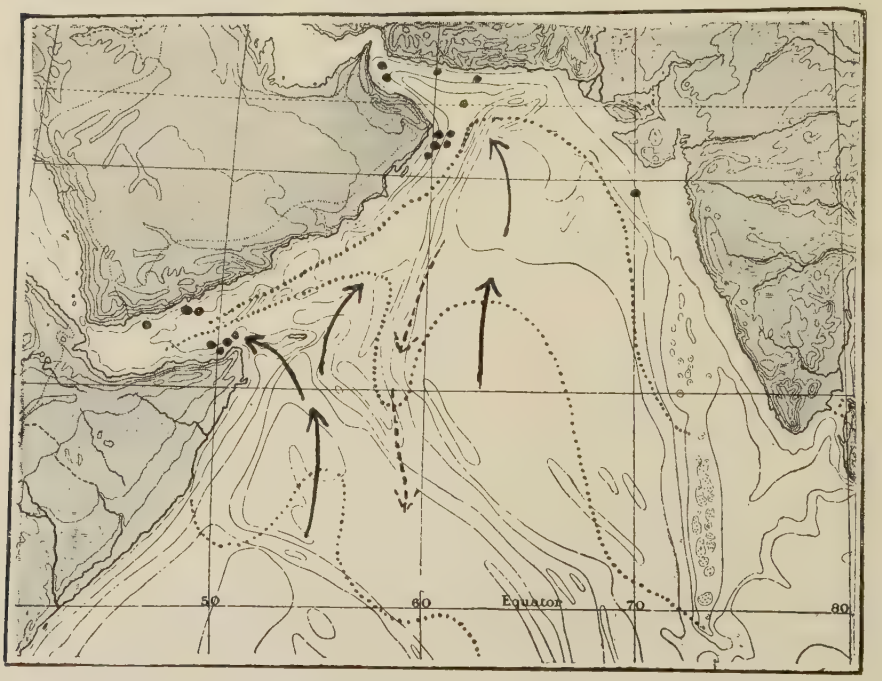

Fig. 6.—Positions at which fish-remains occurred in the bottom deposits.

In fig. 6 I have indicated the areas in which fish remains were present in the bottom deposit and have given the direction of flow of the water at a depth of 200 m. The main areas of deposit are the Gulf of Aden on the west and the region of Ras el-Hadd and the Gulf of Oman on the east : between Ras Fartak and Masira Island no such remains were present though one might have expected that they would be present along this stretch of the coast. As we shall see later (*vide infra*, p. 203) the predominant species that are present in this area between the depths of 200 and 400 m. are certain species of Crustacea, particularly the following :—

Puerulus sewelli Ramadan (=*Panulirus angulatus* Alcock).
Scyllarus orientalis (Spence Bate).
Parilia alcocki Wood-Mason.
and *Squilla investigatoris* Lloyd.

and it seems probable that these carnivores are largely responsible for the absence of fish remains.

Turning now to the distribution of the bottom fauna, it is generally accepted that each animal is adapted to the conditions under which it lives and that, as Fowler & Allen (18) have pointed out (p. 294), " the local distribution of the fauna within the narrower limits of each region appears to depend largely on the varying character of the sea bottom ". Vevers (19) from his photographic work on the sea-bottom in the neighbourhood of Plymouth has shown that within quite a short distance the character of the epi-fauna may change without there being any visible corresponding change in the nature of the bottom, and he has also concluded that in the case of the Ophiuroid, *Ophiothrix fragilis*, dense aggregations are not of seasonal occurrence but represent a constant population that can be found at any time of the year. In the region we are considering there is evidence that a species of *Squilla*, *S. investigatoris* Lloyd, has maintained a dense population in the same area for at least 27 years and in another region two other crustacea, *Scyllarus orientalis* (Spence Bate) and *Puerulus sewelli* Ramadan (=*Panulirus angulatus* Alock) were taken in a single haul of the trawl in approximately the same numbers by the " Investigator " in 1906 and the " Mabahiss " in 1933.

Since the " Challenger " Expedition it has been realized that the benthic fauna, as a rule, steadily decreases with increasing depth and Sverdrup, Johnson & Fleming (20) give the following table, taken from the " Challenger " results :—

Zone m.	No. of Stations	Average yield of species at each Station	Average yield of individuals at each Station
180	70	62·8	—
180–900	40	51·2	150
900–1800	23	30·9	87
1800–2700	25	24·0	80
2700–3600	32	15·6	39
3600–4500	32	10·6	25·6
4500	25	9·4	24

It was to be expected that the same phenomenon would be experienced in this coast line; but it was surprising to find that in the region of Ras el-Hadd there is a complete or nearly complete absence of a bottom fauna in the mid-depths.

A study of the more conspicuous elements in the fauna in different parts of this coast line, shows that there are considerable differences in different areas, and I have divided the coast line into seven such areas (*vide* fig. 7).

Area I. Commencing in the Gulf of Aden the first area, Area I, is situated around Cape Guarda-fui on the south side of the entrance to the Gulf. Here the fauna is rich and varied on the continental shelf in depths ranging from 37 to 91 m. and down the upper part of the continental slope: conspicuous among the fauna were several Gorgonacea *Versluysia ramosa* Thom. & Hend., *Acabaria mabahissi* Hickson and *Solenocaulon ramosum* Hickson. Both these last were brightly coloured a red or pink and associated with them were a number of Ophiuroids and Polychaet worms of the species *Syllis* (*Haplosyllis*) *spongicola* Grube, that were similarly coloured to match the Alcyonarian on which they were living; there were a number of Echinoderms, including 16 species of Echinoids; and among the Crustacea we obtained 13 specimens of *Puerulus sewelli* Ramadan, which becomes so common on the northern side of the entrance to the Gulf; there were also numerous Hydroids and Sponges. But the predominant animals appear to be the Mollusca and especially a species of Lamellibranch of the genus *Chione**. The Scaphopoda also seem to be

* I am indebted to Dr. Rees of the British Museum (Nat. Hist.) for the identification of this species.

abundant in this area for as many as nine species were represented in the catches. These Mollusca were particularly abundant at a depth of about 200–400 m.; a grab sample, of half a square metre area, from a depth of 201 m., yielded 30 examples of *Chione* and 57 of *Dentalium*, and at a little lower depth in a similar sample from 257 m., there were 29 live specimens of *Chione* and numerous dead shells, as well as ten specimens of *Dentalium* (*Dentalium*) *adenense*, a new species (*vide* Ludbrook (20)), and one each of two other species. At this depth the bottom consists of a green sandy mud. As we pass down the continental slope the fauna diminishes somewhat but even at 2,300 m. there is a good and varied fauna, two species of Ophiuroids being well represented, namely *Ophiura irrorata* (Lyman) by 35 specimens and *Placophiothrix purpurea* (von Martens) by 32.

The next two areas lie at the head of the Gulf on the two sides.

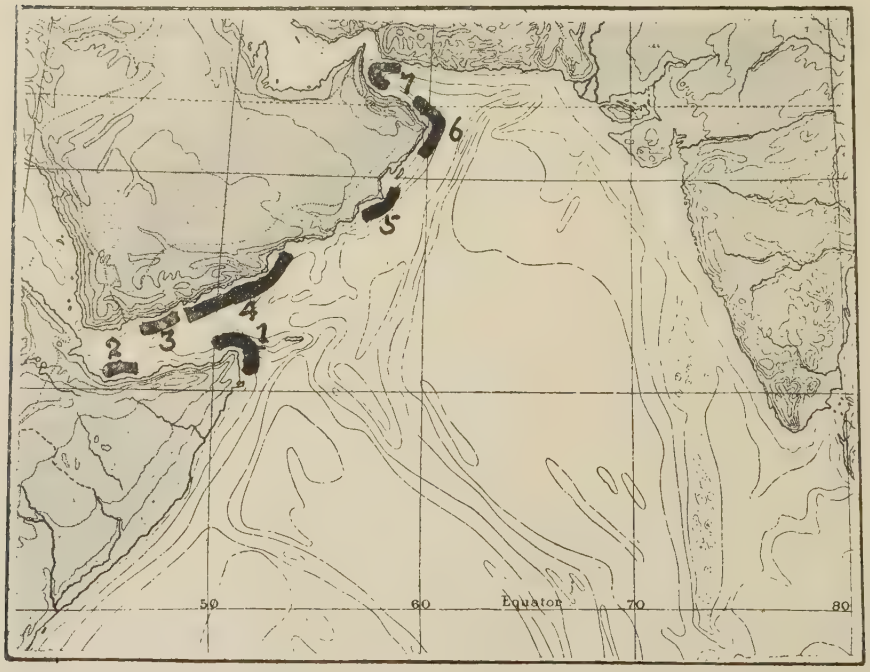

Fig. 7.—Faunistic Areas of the South Arabian coast.

Area II. This is situated off Berbera and here we carried out only a single trawl in 186 m. depth: unfortunately the result was not very satisfactory as the trawl failed to fish properly. Nevertheless, we obtained evidence of a good fauna, but here the predominant species was a Pennatulid, *Protoptilum cyaneum* Kükenthal (*vide* Hickson (22)); many examples were more or less complete and in addition there were hundreds of stalks from which the flower-like body of the animal had become detached. Among other groups the most plentiful was a Penaeid, *Penaeopsis rectacutus* Spence Bate, of which 60 examples were taken.

Area III. This area lies on the north side of the head of the Gulf and extends eastward from Aden to the promontory of Ras Aulaki. Here the fauna at a depth of some 200–300 m. is amazingly rich. In a single haul of the "Agassiz" trawl at a depth of 220 m. certain species were present in great numbers: among the Echinodermata an Echinoid, *Clypeaster annandalei* Koehler, that is a mud feeder, was represented by between 4,000 and 5,000 examples, and an

Asteroid, *Anthenoides cristatus* (Sladen), by 495. One of the Pennatulacea, *Umbellula huxleyi* Kolliker, yielded 240 specimens and among the Crustacea we obtained 150 examples of *Puerulus sewelli* Ramadan and 96 specimens of *Scyllarus orientalis* (Spence Bate). We also obtained four specimens of the Stomatopod *Squilla investigatoris* Lloyd that becomes so common a little farther to the east.

In this area certain Lamellibranch molluscs must be plentiful, for shells of a species which Stubbings identified as *Venus torresiana* (Smith) were common in the samples brought up by the grab from about 200–300 m. depth, and from a trawl in 220 m. depth many hundreds of these valves were thrown overboard : in the sample that was kept and preserved about 50 per cent were providing a base to which small Actinians were attached. At a somewhat greater depth, of about 1000 m., there is still a rich and varied fauna and the Crustacea appear to be particularly well represented, as the following list shows :—

Panaeidea
- *Aristeus alcocki* Ramadan ... ... 6 specimens
- *Hymenopenaeus propinquus* (de Man) ... ... 9 ,,
- *Hemipenaeus crassipes* (Wood-Mason) ... ... 6 ,,

Palinura
- *Polycheles typhlops* Heller ... ... 14 ,,
- *Nephropsis stewarti* Wood-Mason ... ... 2 ,,

Caridea
- *Acanthephyra fimbriata* Alcock & Anderson ... 7 ,,
- *Nematocarcinus cursor* A. M.-E. ... ... about 50 ,,
- *Plesionika bifurca* Alcock & Anderson ... ... 13 ,,
- *Heterocarpus dorsalis* Spence Bate ... ... 16 ,,
- *Psytharocaris infirmis* Alcock & Anderson ... ... 10 ,,
- *Alphaeus macrosceles* Alcock & Anderson ... ... 16 ,,
- *Glyphocrangon smithi* Wood-Mason ... ... 8 ,,
- *Pontoptilus indicus* de Man ... ... 6 ,,

Anomura
- *Munidopsis wardeni* Anderson ... ... many ,,
- *Munida andamanica* Alcock ... ... 3 ,,

Brachhyura
- *Homola megalops* Alcock ... ... many ,,
- *Lyreidus channeri* Wood-Mason ... ... 2 ,,

In addition 60 examples of the Madreporarian coral *Caryophyllia mabahithi* J. S. Gardiner were taken.

In the next two areas, IV and V, there is a rich and varied fauna living on the continental shelf in depths of 100 m. or less : such a condition is to be expected in a stretch of coast-line along which there is a copious growth of sea-weed. The predominant species appear to belong to two groups, Polychaeta and Ophiuroidea. The following number of species were obtained in those groups that have already been reported on :—

Crustacea
- Cirripedia ... 5 species
- Amphipoda ... 35 ,, : *Lembos podoceroides* Wlkr. ... 175 examples.
- Caridea ... 5 ,,
- Penaeidae ... 1 ,,
- Palinura ... 1 ,,
- Paguridae ... 5 ,,
- Stomatopoda ... 1 ,,
- Pycnogonida ... 7 ,,

Echinodermata			
Asteroidea ...	7 species:	*Stellaster colubrinus* Macan ...	27 examples
Echinoidea ...	8 ,,	*Clypeaster rarispinis* de Meijere	*c.* 67 ,,
		Clypeaster fervens Koehler ...	29 ,,
Ophiuroidea...	14 ,,	*Ophiothela coerulea* H. L. Clark	242 ,,
		Ophiactis carnea Ljungman ...	93 ,,
		Macrophiothrix brevipeda H. L. Clark	54 ,,
		Placophiothrix proteus (Koehler)	34 ,,
Crinoidea ...	2 ,,		
Mollusca			
Opisthobranchia	8 ,,		
Polychaeta	44 ,,	*Stylarioides xanthostictus* (Schmarda)	30 ,,
Sipunculoidea ...	3 ,,		
Gorgonacea ...	8 ,,	*Acabaria erythraea* Ehrenberg, a large number.	
Madreporaria ...	2 ,,	*Psammocora superficialis* J. S. Gardiner	50 ,,

In addition, in certain spots, as for instance where there is a patch of stones and rock fragments with angular edges and a considerable growth of Lithothamnium in lat. 19° 22′ 36″ N., long. 57° 53′ 00″ E., depth 13 m., there is a very rich fauna, which included numerous small Holothurians of a *Cucumaria*-like form, several Lamellibranch Molluscs of a *Cardium* or *Arca* type, several Polyplacophora and Gastropoda of several species; numerous Alcyonarians and Antipatharians, with a few Actinians; several Hydroid colonies and some sponges. An interesting feature of the fauna here was the number of animals that were protectively coloured a red or pink, resembling the Lithothamnium.

Area IV. This area extends eastward along the coast from Ras Aulaki to Ras Fartak and beyond: at a depth of about 200 m. the Crustacea seem to predominate; the predominant species, however, is a Stomatopod, *Squilla investigatoris* Lloyd. The R.I.M.S. "Investigator" took over 500 examples of this species in a trawl at 201 m. depth, and the "Mabahiss" obtained as many as 14 in a grab sample of half a square metre at a depth of 191 m. In the intermediate depths between 1,000–1,500 m. the fauna was less rich than in Area III and the Crustacea, that had been so plentiful further west, are here found in fewer numbers and in some instances are replaced by a different species:—

Aristeus alcocki Ramadan is replaced by *Hemipenaeus crassipes* (Wood-Mason).
Plesionika bifurca Alck. & Andsn. is replaced by *P. martia* (A. M.-Edw.).
Munida andamanica Alcock is replaced by *M. militaris* Henderson.

It is interesting to note that it was in this region that the "Investigator" obtained two examples of the deep-sea Isopod, *Bathynomus giganteus* A. M.-Edw. The Echinodermata were moderately well represented: nine species of Ophiuroids, four of Asteroids and three of Echinoids being obtained. A few species of Polychaeta were also present, two of them, *Hyalinœcia tubicola* (O. F. M.) and *Phyllochaetopterus* sp., in large numbers. In the greatest depths of 2,000 m. there is a further reduction in the fauna; a few Crustacea were still present and the Echinodermata were represented by five species of Ophiuroidea, one of which, *Ophiomusa lymani* (Wyv. Thom.), occurred in large numbers, 206 specimens being taken: five species of Madreporarian corals were also taken, *Caryophyllia clavus* Scacchi being represented by 86 living examples.

Area V. This area lies in the region of the Korya Morya Islands. Here, in depths of from 250 to 400 m., the fauna is markedly less rich than farther westwards; the "Investigator" in this area obtained a small catch, the predominant species in which was the crab, *Parilia alcocki* Wood-Mason, of which she obtained over 50 specimens: she also obtained many examples of the Gastropod Molluscs *Rostellaria delicatula* Nevill and *Pyrula investigatoris* E. A. Smith, the former of which becomes very common in the Gulf of Oman.

In the mid-depths the fauna is poor, due at least in part to the character of the sea floor, which south of the Korya Morya Islands at 1,415 m. depth is composed of angular granite-fragments, forming a scree slope, and in deeper depths to the character of the bottom mud, which is of a green-brown colour, and farther to the east, near Ras el-Hadd, is almost completely devoid of any epi-fauna. Between 1,500 and 1,750 m. depth the only animals obtained were two specimens of a Gorgonid, *Acanella africana* Kükenthal, and two Crustacea, provisionally diagnosed as an *Uroptychus* and a *Munidopsis*.

Area VI. In this area, which is situated around Ras el-Hadd, the fauna of the mid-depths between some 200 m. and 800 m. on the south side of the Cape and down to about 1,200 m. on the east becomes remarkably scanty, and over most of the area is completely absent. On the continental shelf there is a rich fauna, and at a depth of 16–22 m. the predominant species is, as in Area II, a Pennatulid, but in this area it is *Cavernularia orientalis* Thom. & Simp., of which we obtained 200 examples; other specimens include four species of Polychaet worms, a Crustacean, *Penaeopsis* (*Metapenaeopsis*) *vaillanti* Nobili, of which we took 13 examples, and a Madreporarian coral, *Heterocyathus aequicostatus* (Ed. & H.), represented by 22 examples.

On the south side of the Cape below about 800 m. there is a moderately good fauna, for the "Investigator" (*vide* Lloyd (4)) in 1906, at a depth of 900 m., obtained eight species of Crustacea, one Asteroid, *Mediaster* sp., several bivalve Molluscs of the genus *Nucula*, a number of Polychaeta, some Gorgonacea and two specimens of a Hydroid, *Branchiocerianthus imperator*. At a depth of 1,046 m. the "Mabahiss" also obtained a good catch, Ophiuroids being particularly common; thousands of these animals were obtained and, although only a relatively small proportion of the whole catch was preserved, one species, *Ophiura megalaspis* H. L. Clark, was represented by 142 examples; many small Holothurians were also present: among the Crustacea we obtained 61 specimens of *Hymenopenaeus fattahi* Ramadan and 50 *Nematocarcinus cursor* A. M.-Edw. On the east side of the Cape, from three hauls of the dredge between the depths of 425 and 800 m., all we obtained were a few moribund or dead examples of the Crab, *Encephaloides armstrongi* Wood-Mason, some empty shells of the Mollusc *Rostellaria delicatula* Nevill, and some empty Serpulid worm-tubes. In 1253 m. all we got were three examples of the Polychaet *Maldane sarsi* Malmgren, var. *tropica* Monro, and a single Crab, a species of *Paralomis*. Due east of Ras el-Hadd, at a depth of 1,984 m., we found a very scanty fauna represented by a single Crustacean, *Polycheles andamanensis* Alcock, one Ophiuroid, *Ophiuroa irrorarta* (Lyman), and one Asteroid, *Pseudarchaster diversigranulatus* Macan, and two dead Matreporarian corals, *Deltocyathus murrayi* J. S. Gardiner and *Bathyactis symmetrica* Pourtales, each represented by a single specimen. Farther away to the north-east, in 3,351 m. depth, the fauna was still very scanty, the only specimens obtained being one each of *Persephonaster gracilis* (Sladen) and *Zoroaster alfredi* Alcock, while a single prawn, *Acanthephyra eximia* Smith (=*A. brachytelsonis* (Spence Bate)), was in all probability caught on the way up.

This azoic area appears to extend along the Arabian coast at least as far north as Muscat, for in this region, in hauls of the trawl at depths of 265 m., 610 m. and 1745 m., all we got were dead shells of the carnivorous Mollusc

Rostellaria delicatula Nevill, six examples of a single Polychaet, *Vermiliopsis acanthophora* Augener, living in mud-tubes, and four examples of a Salp, *Metcalfina hexagona* Q. & G., caught almost certainly on the way up.

Area VII. The last area to be considered lies at the head of the Gulf of Oman close to the Strait of Ormuz. Here there is a good and varied fauna at depths down to 210 m. The most conspicuous species are a Holothurian, probably *Holothuria hamata* Pearson, of which we obtained 666 examples, and the carnivorous Mollusc *Rostellaria delicatula* Nevill, represented by 213 specimens, many of which were bearing a *Crepidula*-like mollusc on its shell; there was also a number of examples of a species of *Murex*. In addition, examples of the genus *Pyrula* were also taken; these appear to belong to two species, one of which is *P. investigatoris* E. A. Smith and the other may be *P. sewelli* Prashad that was recorded from the Laccadive Sea ("Investigator", Sta. 611, depth 176–180 fm.). The Crustacea and Polychaeta were also well represented. Among the former were five species of Stomatopoda, represented by 21 examples, five species of Caridea, *Plesionika minor* Calman (20 examples), and seven species of Paguridea. Among the Madreporarian Corals *Heterocyathus heterocostatus* Harrison was represented by 24 specimens.

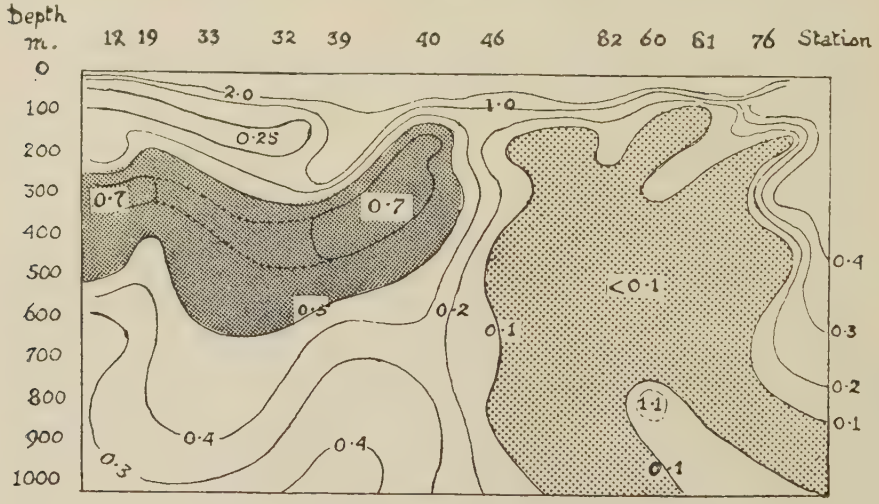

FIG. 8.—Oxygen content of the sea-water in c.c. per litre at different depths along the South Arabian coast.

The peculiar type of bottom deposit, a green-brown mud that is devoid of any epi-fauna, which is found in the mid-depths around Ras el-Hadd and extends up into the Gulf of Oman, is of considerable interest not only to biologists but to geologists also. In this mud bacteriological changes appear to predominate over the changes brought about by the feeding of the epi-fauna, and associated with this is the presence of considerable quantities of H_2S gas (*vide* Mohamed (5), p. 200), accompanied by a great reduction in the amount of O_2 in the water masses at about the same depth. In a previous paper Professor Louis Fage and I (23) called attention to the importance of a study of the Minimum Oxygen Layer that is found in all the great oceans at some depth below the surface. The presence of this layer may be due either to the metabolic activity of a concentration of planktonic organisms or to bacterial activity on the dead and decomposing remains of planktonic organisms that are sinking to the bottom; at the two ends of the South Arabian coast we seem to have examples of each of these processes (fig. 8). At the west, in the Gulf of Aden, there is a diminution of the dissolved oxygen, at a depth of some 50–80 m., in

lat. 13° 05′ 36″ N., long. 46° 24′ 42″ E., and not far from this region in May, in lat. 13° 51′ 30″ N., long. 47° 49′ 12″ E., a trace of H_2S was detected in a sample of the bottom of soft green mud at a depth of 95 m. Below this depth the oxygen content starts to rise again, though only very slowly; this is probably due to the influx of the mass of Indian Ocean water that, as we have seen (*vide supra*, p. 198), enters the Gulf between 50 and 1,000 m. depth. This water supports a rich plankton, and between some 450 and 1,050 m. we obtained 252 examples of the deep-sea Medusa, *Periphylla hyacinthina* Steenstrup, and 30 or more specimens of *Atolla wyvillei* Haeckel, and over 4,000 examples of an Alima larva belonging to a single species, possibly *Squilla investigatoris* Lloyd, which is so abundant in Area IV. At the east end of the Arabian peninsula there is a mass of water, the Indian Intermediate current, which is

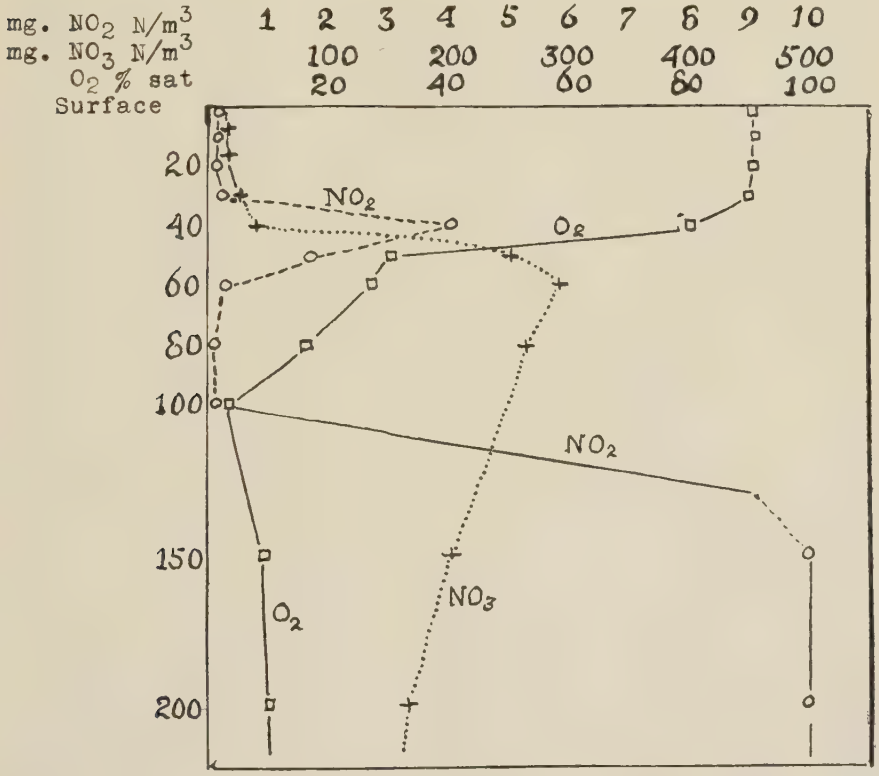

FIG. 9.—The amount of oxygen, nitrite and nitrate in the sea-water at various depths in the entrance to the Gulf of Oman (John Murray Station 61) (after Gilson, 1937).

characterized by a low pH and a very low oxygen content, and extends down to well below 1,000 m. depth; here, as I have already stated (*vide supra*, p. 198), the main catch consisted of great numbers of the Salp *Thalia democratica* Forskål that appeared to be dead and decomposing. Among the Copepoda 22 and 23 deep-sea species respectively are recorded from the west and east areas, but of these only four species occur in both: the greatest difference between the two regions is to be found in the number of individuals captured; thus, between the depths of 250 to 960 m. in the Gulf of Aden, among the 22 species recorded 5,783 adult individuals were taken, whereas at the entrance to the Gulf of Oman, among 23 species taken between the depths of 500 to 1,500 m. only 296 individuals were obtained.

Regarding the origin of this North Indian Intermediate Current, Mohamed ((5), p. 191) remarks : " it is thus seen that whereas the origin of the North Indian deep current is connected with the strong evaporation during the winter in the coastal regions of the Arabian Sea, the properties of low pH and low oxygen content, which characterize the water mass and indicate its source, are due to intense organic oxydations taking place in these coastal regions on account of the development of a sharp thermocline in the summer ", and he points out that the zone between the depths of 83–102 m. and 1,253–1,536 m., in which there is an absence of life, corresponds remarkably well with the limits of the minimum pH layer and, he might have added, the low oxygen content. Gilson ((15), p. 51) has remarked that the " phenomenally high nitrite concentration recorded between 150 and 600 m. and at 1,000 m. call for some comment " (*vide* fig. 9), and he points out that this condition is found in the neighbourhood of the ' Dead Area '. It thus seems highly probable that these characters of the water mass at the entrance to the Gulf of Oman and round Ras el-Hadd are to be attributed to intense bacterial action on dead and decomposing organic matter, either in the bottom deposit or while sinking down from the upper stratum of the sea.

Seiwell & Seiwell (24) have suggested that the greatest concentration of sinking decomposing plankton will be found in the Atlantic Ocean near the level of minimum oxygen content of the water, which they place at the depth where the water has a density of 27·232±0·008. In the present observations such a density is present near the 1000 m. depth level, and the minimum oxygen layer is at about 800 m. level. I give below the density of the sea-water and its oxygen content at various depths :—

Depth (m.)	Temp. (°C.)	Salinity.	Density (*in situ*)	O_2 content (c.c./litre)
400	14·09	34·53	26·60	0·422
600	12·07	35·39	26·896	0·336
800	10·36	35·28	27·139	0·046
1,000	9·00	35·14	27·258	0·086
1,500	5·575	34·85	27·492	0·611
2,000	3·18	34·59	27·648	1·43

Thus it appears possible that the great concentration of the decomposing carcasses of the Salp *Thalia democratica* Forskål, to which I have already referred (*vide supra*, p. 198), is due to their being held up at about this depth.

Lees (25) compares the presence of H_2S in the region off Ras el-Hadd with that of the deep water of the Black Sea, and he attributed it to stagnation of the water behind a hypothetical submarine barrier. This, however, appears to be unacceptable for, far from being stagnant, the water overlying this azoic region has been shown to be the commencement of the North Indian Intermediate Current that can be traced flowing southwards, and as Mohamed ((4), p. 169) has shown, this mass of water can be traced as far as the line from Ceylon to Zanzibar, with a nucleus at 800 m. depth and a low limit below 1,500 m.

Brongersma-Sanders (6) has suggested that areas such as this are in all probability regions of Petroleum-formation, and it is interesting to note the geographical relationship of this area with the oil-bearing regions of Southern Asia (fig. 10). During the Tertiary Epoch a gulf of the Arabian Sea ran in a north-easterly direction over a large part of what was formerly the Punjab of India but is now part of Pakistan. This gulf was separated from the Tethys Sea by the gradually rising Himlayan Mountains. On the north side of this barrier the rocks are fossiliferous, whereas the sedimentary rocks on the south side are

for the most part devoid of fossils; but in Sind Blanford has recorded the existence of "a bed abounding in fossil shells of a species of *Rostellaria*, apparently the *R. columbaria* of D'Archiac & Haine, but a very different form from the true *R. columbaria* of Lamarck". This bed Blanford ascribes to the Upper Eocene, and it apparently corresponds to the Ranikot and Laki beds

FIG. 10.—Map showing the regions in which the bottom water is devoid of living organisms and the situation of Petroleum Deposits in the Middle East.

of that period: these beds are known to be petroliferous, and it seems possible that the region round Ras el-Hadd, in which the only animal remains of any note are also shells of a species of *Rostellaria, R. delicatula*, may also be a region in which the formation of petroleum is going on at the present day.

REFERENCES.

(1) FAGE, L. 1951. *Ann. Biol.*, **27**.
(2) HOLME, N. A. 1953. The Biomass of the Bottom Fauna in the English Channel off Plymouth. *J. Mar. biol. Ass.*, **32**.
(3) CARRUTHERS, J. N. 1951. Observations continues sur les movements de l'eau de mer dans les zones de Peche. *Conference du Centre de Recherches et d'Etudes oceanographiques*, Conf. No. 1, 1951.
(4) LLOYD, R. E. 1907. Contributions to the Fauna of the Arabian Sea, with descriptions of new Fishes and Crustacea. *Rec. Ind. Mus.*, **50**, No. 1.
(5) MOHAMED, A. F. 1940. The Distribution of Hydrogen-Ion concentration in the North west Indian Ocean and Adjacent Waters. *Sci. Rep., John Murray Exped.*, **2**.

(6) Brongersma-Sanders, M. 1948. The Importance of Upwelling Water to Vertebrate Palaeontology and Oil-Geology. *Kon. Ned. Ak., Verh. Wet., Afd. Nat.* (2) D1, **45**, No. 4.
(7) Farquharson, W. I. 1936. Topography, with an Appendix on Magnetic Observations. *Sci. Rep. John Murray Exped.*, 1933–34, **1**.
(8) McEwen, G. F. 1916. Summary and Interpretation of the Hydrographic Observations made by the Scripps Institute for Biological Research of the University of California, 1908–1915. *Univ. Calif. Pub. Zool.*, **15**.
(9) Hornell, H. & Nayudu, R. 1924. A Contribution to the Life-History of the Sardine. *Madras Fish. Bull.*, **17**.
(10) Karsten, G. 1907. Das Indischen Phytoplankton. *Wiss. Ergebn. "Valdivia"*, **2**.
(11) Subrahmanyan, R. 1946. A Systematic Account of the Marine Plankton Diatoms of the Madras Coast. *Proc. Indian Acad. Sci.*, **24**.
(12) Stiasny, G. 1937. Scyphomedusae. *Sci. Rep. John Murray Exped.*, 1933–34, **4**.
(13) Peterson, C. G. J. & Boysen Jensen, P. 1911. Valuation of the Sea. I. Animal Life of the Sea-Bottom, its Food and Quantity. *Rep. Danish biol. Sta.*, **2**.
(14) Matthews, D. J. 1926. The Percy Sladen Trust Expedition to the Indian Ocean in 1905. No. VII. *Trans. Linn. Soc. Lond.*, **19**.
(15) Gilson, H. C. 1937. Chemical and Physical Investigations. The Nitrogen Cycle *Sci. Rep. John Murray Exped.*, 1933–34, **2**.
(16) Wiseman, J. D. H. & Bennett, H. 1940. The Distribution of Organic Carbon and Nitrogen in Sediments from the Arabian Sea. *Sci. Rep. John Murray Exped.*, 1933–34, **3**.
(17) Stubbings, H. G. 1939. The Marine Deposits of the Arabian Sea. *Sci. Rep. John Murary Exped.*, 1933–34, **3**.
(18) Fowler, G. H. & Allen, E. J. *Science of the Sea.* Clarendon Press, Oxford.
(19) Vevers, H. G. 1951. Photography of the Sea Floor. *J. Mar. Biol. Ass.*, **31**.
——. 1952. A Photographic Survey of Certain Areas of Sea Floor near Plymouth. *Ibid.*, **31**.
(20) Sverdrup, H. W., Johnson, M. W. & Fleming, R. H. 1944. *The Oceans.* New York.
(21) Ludbrook, M. H. Report on the Scaphopoda. *J. M. Reports*, in the press.
(22) Hickson, S. J. 1937. The Pennatulacea. *Sci. Rep. John Murray Exped.*, 1933–34, **4**.
(23) Sewell, R. B. S. & Fage, L. 1948. Minimum Oxygen Layer in the Ocean. *Nature, Lond.*, **162**, 949.
(24) Seiwell, H. R. & Seiwell, G. E. 1938. The Sinking of Decomposing Plankton in Sea-water and its relationship to Oxygen Consumption and Phosphorus Liberation. *Proc. Amer. phil. Soc.*, **78**.
(25) Lees, G. M. 1937. Black Sea Conditions in the Arabian Sea. *Bull. Amer. Ass. Petr. Geol.*, **21**.

OBITUARIES

Reginald E. C. Beale, died on 14 November 1952, at the age of 75 years. Mr. Beale commenced his association with horticulture 55 years ago, later becoming a Director of Messrs. Carters Tested Seeds Limited. From an early age he concentrated his attention on grass seeds and on the construction of lawns and golf courses and became one of the leading consultants at home and overseas, including the All England Tennis Club at Wimbledon. He was the author of several books, *The Practical Greenkeeper, Lawns for Sports*, and *The Book of the Lawn.*

Mr. Beale was also a gifted craftsman and held a silversmith's licence. His work was very fine—judged on the highest standards. He was unmarried. He was elected a Fellow in 1907. M. A. F. Sutton.

Richard Higgins Burne, M.A.(Oxon), F.R.S., F.L.S., died on 9 October 1953 in his 86th year, so closing over fifty years' devotion to the Linnean Society. A contributor to the Society's scientific activities long anterior to his election as Fellow in 1912, Burne served frequently on the Library and Audit Committees, as member of Council thrice (1916–20, 1923–26, 1938–44),

and as Vice-President twice (1925–26, 1938–39). In 1928 he was urged to accept the Zoological Secretaryship, but declined, to the general regret. His mere record of office bespeaks the esteem in which he was held by the Society which profited over many years from his sagacity, his disinterested advice, and his unrivalled knowledge. In earlier years no Presidential Reception was complete without its display of Burne's exquisite dissections and preparations (masterpieces of prosectorial art) designed to illustrate some particular biological principle.

Burne was born in London on 5 April 1868, youngest son of Richard H. Burne, solicitor, and was educated at Winchester and Oriel College. Graduating in 1889 he studied natural science under G. B. Howes at the Royal College of Science, London, until his appointment in 1892 as Anatomical Assistant in the Royal College of Surgeons Museum. Under Howes, Burne's natural aptitude for zoological research and his inherent talents as prosector and artist became manifest. His notebooks of the period remain models of observational accuracy and succinct expression, their working illustrations at once artistic gems and object-lessons in morphological exposition.

The 1892 appointment provided Burne with the ideal field for the exercise of his natural interests and abilities, and under various titles (Assistant Conservator, 1908; Physiological Curator, 1912–34; Acting Conservator, 1933–34), he devoted over 40 years to the onerous and responsible task of curating, cataloguing and developing the vast comparative collections of the Hunterian Museum. The greater part of this period was served under the Conservatorship of Sir Arthur Keith in a felicitous partnership which greatly enhanced the prestige and value of the Museum. Apart from its 17,000 human and comparative osteological specimens, the Hunterian Museum contained over 15,000 'physiological' preparations illustrating the several systems, parts and organs forming the machinery of vertebrate and invertebrate life, and arranged, not in systematic, but in functional, fashion, to exemplify the Hunterian doctrine touching form and function. The re-cataloguing of this Physiological Series (unattempted since Owen's day) occupied Burne from 1892 to 1934 and involved continuous and meticulous labour in vetting old and preparing new specimens, in re-writing and amplifying descriptions, in providing informative summaries regarding animal systems and organs, and in executing a variety of illustrations necessary to the text—a herculean labour likely to daunt anybody less knowledgeable or gifted.

Some parts of the new Physiological Catalogue saw publication—Vol. I, 1900 (Charles Stewart and Burne), Vol. II, 1902 (Burne, W. L. H. Duckworth and (Sir) Grafton Elliot Smith), Vol. III, 1907 (Stewart and Burne). But the bulk remained unpublished, in the shape of twenty-odd enormous typewritten volumes, lavishly illustrated by Burne's inimitable hand, and constituting by their treatment of principles and detail a veritable *Summa Zoologica*. These volumes perished, with most of the relevant preparations, by enemy action in 1941. There now exists nowhere any comparable or even approximate synthesis of zoological knowledge, for the Hunterian system of classification was, unfortunately, unique.

The Council of the Royal College of Surgeons recognised Burne's services by the bestowal of their Honorary Medal (1925) and by electing him a Hunterian Trustee after his retirement.

In 1934 Burne became an honorary worker at the British Museum (Natural History), devoting himself to the making of preparations illustrative of the structural peculiarities of the Cetacea, of which group he possessed an anatomical knowledge unrivalled since Hunter and Clift. The outbreak of war in 1939, and later, the onset of retinal degeneration, prevented the completion of this project. His finished preparations, however, are on permanent exhibition in the Museum's Whale Hall and a commemorative 'Handbook of R. H.

Burne's Cetacean Dissections' (reproducing many of Burne's original illustrations of his preparations) was issued by the Trustees (1952).

In addition to the Linnean Society, Burne served other learned societies. His interest in the mollusca was reflected in his long membership of the Malacological Society, from 1895 (two years after its inception) to 1951. Burne served as Acting Secretary (1901–2) of the Society and Secretary (1902–7). Between 1895 and 1910 he published some ten notable papers on molluscan anatomy and staged a variety of anatomical exhibits at the Society's meetings. These demonstrations included a wax-plate reconstruction of the nervous system of *Nucula*, a series of *Nautilus* dissections and two partly dissected specimens of *Spirula* (these last being most probably Owen's material from the stores of the Hunterian Museum).

Burne was a Fellow of the Zoological Society from 1890 till his death. He attended regularly its scientific meetings, and served repeatedly on the Society's Council (1910–11, 1912–15, 1917–19, 1926–28, 1929–33, 1937–42) and was thrice Vice-President (1914–15, 1917–19, 1939–41). On the Publications Committee he served for over 40 years, on the Prosectorial Committee almost continuously from 1905 to 1945, and on the House and Library Committee for 15 years.

A member of the Anatomical Society from 1896 until his death, Burne was, in his earlier years, a regular if reticent attender at its meetings, occasionally displaying thereat, in the form of superb comparative preparations, his unrivalled knowledge and prosectorial skill.

Burne's relatively few but authoritative papers (on molluscan, piscine and mammalian morphology) appeared between 1894 and 1939 in the publications of these Societies and in those of the Royal Society—to which he was somewhat tardily elected in 1927.

Erect of carriage, gravely courteous and dignified of presence, Burne was characterized in speech by a slight but attractive impediment of hesitancy: his demeanour was reticent almost to diffidency, but his humorous and observant eye missed little. Serenity and winsomeness of manner were the exterior manifestations of a character compounded of absolute integrity, impressive self-discipline and a profound respect for truth. Insincerity in any form he abhorred, yet he was reluctant to criticize and refused always to condemn. Rather, he credited others with his own high standards and ideals, and in consequence evoked their best efforts, besides securing their affectionate regard. His knowledge of persons and motives was penetratingly acute, his opinions were carefully and surely formed and his judgments unbiassed: his counsel was therefore much sought and deeply valued by the governing bodies of the many learned societies claiming his allegiance. None ever appealed to his knowledge and experience without receiving the most generous response, and younger men owed him much in this respect, and as an exemplar. For Burne was that modern rarity—the truly disinterested man of science. Dispassionately devoted to biological truth and indefatigable in its pursuit, he was unaffectedly indifferent to any credit for achievement. Sufficient for him that the task was done and knowledge enlarged.

Typical of the man, too, was his wholehearted concentration upon the particular business in hand, his talents being equally engaged upon the painting of scenery for his children's theatricals as upon the composition of a scientific paper. Nothing undertaken was regarded as unimportant, and he had but one standard of excellence.

His terminal blindness was accepted with characteristic patience and borne with fortitude, its burden eased by family love and the affection of friends. He died, as he had lived, gently, in his sleep. *Requiescat in pace.*

A. J. E. Cave.

Atulananda Das, I.F.S., F.L.S., born at Barisal, Bengal on 10 December 1879, died at Calcutta on 10 December 1952 after a long illness.

Atulananda Das was in charge of the Botanical and Silvicultural Branch of the Direction Division under the Conservators, at Shillong, until his retirement in 1934. He continued to be associated with Forest Botany after his retirement.

He contributed to many scientific journals and his collections have enriched the Forest Herbarium at Shillong.

Mr. Das was elected a Fellow of the Linnean Society in 1935. (A fuller account of his work appeared in *The Indian Forester*, **79,** 516 (1953).)

N. L. Bor.

Professor **Henry Horatio Dixon**, who died on 20 December 1953 in his 85th year, held the Chair of Botany in Trinity College, Dublin, from 1904 to 1950. His name has been familiar to students of botany for nearly 60 years, and his death removes one of the last of those who had already established their reputation in botanical science before the close of the nineteenth century.

Like so many of his generation, he was a member of a large family, being one of nine children and the youngest of seven brothers, three of whom were destined to hold university professorships: in civil engineering, anatomy and botany.

Henry Dixon was born on 19 May 1869. He received his earlier education at Rathmines School, Dublin, and entered Trinity College, Dublin, in 1888. In 1891 he secured one of the coveted Foundation Scholarships in classics. But his real interests were in science, and in 1892 he took his degree in Natural Science, which comprised Botany, Zoology and Geology, being awarded the First Senior Moderatorship with Large Gold Medal.

In later years he sometimes spoke of his regret that he had not received any formal training in physics and chemistry. Actually this was no real handicap to his research, since by his own efforts he acquired a very thorough grounding in physical and chemical principles. In addition, the time he had devoted to the classics and to modern languages undoubtedly had given him something which is often beyond the range of scientists in these days of intensive specialization.

Soon after his graduation he entered Strasburger's laboratory at Bonn where his interest was directed to cytological problems. At Strasburger's suggestion he investigated the fertilisation of *Pinus silvestris*. An account of this work was published in the Annals of Botany in 1894. Later, he extended his cytological studies to the nuclei of *Lilium* and *Fritillaria* and in his paper on the chromosomes of *Lilium longiflorum*, communicated to the Royal Irish Academy in 1895, he made the novel and highly significant statement that the appearance of the chromosomes in the pollen-mother-cells suggested "the idea that each pair has arisen by the approximation of two thread-like portions rather than by the cleavage of one thread".

Dixon's interest in biological mechanisms was demonstrated while he was still a student by a study he made by means of instantaneous photography of the walking of Arthropods, but possibly the deciding factor which diverted his attention from morphological to physiological problems was his association with John Joly, the well-known physicist and geologist. Joly, a neighbour and friend of the Dixon family, invited the 18-year-old Henry to accompany him on a Swiss tour. In Dixon's own words: "That Swiss tour, its climbs and mountain excursions, its companionship, flooded with the light of his speculations, was an experience which can have come to few young men, and it was my great good fortune that it was repeated in various districts in nine successive years". Joly, who was 12 years older than Henry Dixon, was in many

ways a remarkable man. His interests covered a wide range and his contributions to physics and geology were diverse and outstanding. The very close friendship between the two men lasted without interruption until Joly's death in 1933, and the almost daily interchange of ideas on scientific and other questions was of the utmost value to both.

In 1892, on one of their visits to the continent, Dixon and Joly were fortunate in seeing some of Professor Strasburger's experiments which demonstrated that tall trees continued to draw up water even after the stems had been killed. It was obvious that the upward movement of water could no longer be ascribed to the action of living cells in the stem, although the operating mechanism still remained obscure. The problem was one which appealed both to the botanist and to the physicist, and after more than a year of experiment and discussion Dixon and Joly published their well-known theory of the 'Ascent of Sap,' based on the cohesion of liquids.

From 1892 to 1904 Dixon was Assistant to the Professor of Botany, Edward Percival Wright, in Trinity College, Dublin. During this period, in addition to papers on transpiration and on the ascent of sap, he published a number of short papers on very different subjects. Some of these may be mentioned to illustrate the wide range of his interests and his acuity in noting anything which was new and worthy of being recorded. For example, within a short period round about 1900 he published notes or papers on such topics as self parasitism of *Cuscuta reflexa*, the possible function of the nucleolus in heredity, the structure of coccospheres, the first mitosis of the spore-mother-cells of *Lilium*, intracellular rhizoids of the Marchantiaceae, geitonogamy of *Arum maculatum* and adventitious buds on *Drosera rotundifolia*.

During these years he was working in surroundings which were hardly conducive to the investigation of physiological problems. The botanical department was cramped in space and poorly equipped except for morphological or taxonomic studies. Dixon once recalled an occasion when he was carrying out some simple experiments on plant respiration. One of the older generation of botanists who was visiting the laboratory asked him what he was doing. On being told, he remarked "Ah yes, it may well be physics or chemistry, but it is not botany". Dixon also used to speak of the difficulty he experienced during this period in convincing the college authorities that a chemical balance was really needed by a department of botany.

E. P. Wright retired in 1904 and Dixon was appointed to the vacant Chair. Chiefly owing to the determined efforts of Professor John Joly, attention was directed to the growing needs of the science departments. As a result of generous gifts by the late Lord Iveagh, supplemented by donations from a number of graduates, these needs were partly met. Prominent among other additions and improvements was the new School of Botany, which was completed in 1907. Although this building may appear small by modern standards, it was in advance of its time, and the excellence of its general layout and of its equipment was due very largely to the careful planning and attention to detail on the part of Professor Dixon. Provision, which in 1907 seemed adequate, was made for both elementary and advanced teaching, and the department now had laboratories and equipment suitable for physiological and biochemical reseach.

During the next few years Dixon, in collaboration with W. R. G. Atkins, carried out a long series of valuable investigations on osmotic pressures in plants. The work was greatly faciliated by a method he had devised of using a thermocouple for determining the freezing point, and hence the osmotic pressure, of small quantities of plant extracts. The 1914–18 war caused the interruption of these studies, and for a while Dixon put aside physiological research in favour of work which seemed at the time to be of greater national importance. This was his long and painstaking study of the microscopic characters of some forty different varieties of so-called mahogany with a

view to employing these characters for purposes of identification. Mahogany was much used at that time for the manufacture of aeroplane propellers and there was urgent need for a method by which the different varieties could be distinguished.

For some time after the first World War, Dixon's thoughts were largely centred on a new problem : the transport of organic substances in plants. In choosing this line of research he was following the advice he once gave to a young plant physiologist, which was to tackle one of the major problems instead of spending time on minor quests. He himself had already solved one outstanding problem : the mechanism by which water is drawn up to the tops of high trees. This time, unfortunately, he was less successful. His suggestion that the movement of organic substances from the leaves took place mainly through the wood was found to be untenable, as he realized later on. His work was none the less valuable in helping to clarify the problem and in stimulating others to plan and carry out experiments. Although it is now definitely known that the tissue chiefly concerned is the phloem, the problem of elucidating the way in which the movement of solutes takes place remains as a challenge to future workers.

Dixon's work on the translocation of organic substances led him on to studies of the variation of permeability in leaf cells, and in collaboration with T. A. Bennet-Clark he published between 1927 and 1932 a series of papers on factors affecting this permeability.

In later years administrative and teaching duties, which became heavier as the number of students increased, took up more and more of his time. However, occasional papers continued to appear, and a visit to his laboratory in 1945 found him intensely interested in the progress of nuclear division through the endosperm of *Fritillaria* and in the possibility of explaining it in terms of a diffusing hormone.

On his 70th birthday in 1939 he received an address signed by nearly 800 botanists, colleagues and students, and soon afterwards a tribute to himself and his work appeared in the American journal ' Plant Physiology '. But this was not the end of his career ; his 80th birthday still found him carrying on the duties of his Chair. However, during the following year he retired from the professorship, although for a while longer he continued as Director of the Trinity College Botanic Gardens and as Keeper of the Herbarium. The botanic gardens and the herbarium were legacies from the past which he felt must be maintained. In spite of his many other activities, he devoted a great deal of attention to the administration and improvement of the gardens and to the care of the herbarium which included valuable collections made by W. H. Harvey, the algologist, and by other former holders of the professorship. He spent much time in seeing to the arrangement and housing of the specimens and in safeguarding them from the depredations of insects.

When he retired, Henry Dixon had served as a member of the staff of Trinity College, Dublin, for nearly 60 years and his valuable services were recognized by his election in 1950 to an Honorary Fellowship.

During his long career he received many honours. He was elected F.R.S. in 1908 and in 1917 was awarded the Boyle Medal of the Royal Dublin Society. In 1922 he was President of Section K (Botany) of the British Association, and in 1937 was Croonian Lecturer in the Royal Society. He was made a corresponding member, and later a life member, of the American Society of Plant Physiologists and in 1927 was a visiting professor at the University of California. He occupied prominent positions at several meetings of the International Botanical Congress, including that of Honorary President at the meeting held at Stockholm in 1950. His election as president on this occasion, coming as it did towards the close of his long and brilliant career, was a fitting tribute to the services he had rendered to botanical science.

For many years he took a keen interest in the work of the Royal Dublin Society and many of his papers were published in its Scientific Proceedings. He was appointed a Vice-President of the Society in 1930 and President in 1945.

He was elected a Fellow of the Linnean Society in 1925, but distance prevented him from taking an active part in its affairs.

As a plant physiologist Henry Dixon will occupy a place in the history of botany chiefly on account of his work on the ascent of sap ; work which in essentials was completed while he was still a young man. Much of his other work was of the nature of pioneer research which inspired further development by workers elsewhere. In a larger department with greater facilities more might have been done to follow up his ideas, but the privilege of collaboration with Dixon was almost entirely confined to those of us who were fortunate enough to hold the post of Assistant to the University Professor of Botany in Trinity College, Dublin, during some part of the long period when he occupied the Chair.

In such a small department undergraduates saw a good deal of the Professor. This personal contact was shared with successive generations of medical students who attended the lectures and practical classes in botany during the summer term. Dixon always gave a great deal of care and attention to the elementary class and almost invariably gave all the lectures himself. His course of lectures was very different from that usually given to medical and first-year science students 40–50 years ago, in that it commenced with the smaller microscopic forms of algae and fungi, and gradually led on to the structure, reproduction and physiology of the higher plants. Fortunately the substance of these lectures has been put on record in his little book *Practical Plant Biology*. In his classes discipline was strict and first-year students stood somewhat in awe of the Professor, but those who came to know him will not easily forget his geniality and kindliness. Many of his students left Ireland later to work elsewhere and all of them must have retained at least some of the inspiration he had imparted. To get a letter written in his beautiful, neat handwriting was always a joy, and a warm welcome awaited a former student who returned and paid a call at the School of Botany.

In 1907 he married Dorothea Mary, daughter of the late Sir John Franks, C.B. They had three sons who are now engaged in medical and scientific work.

Many will have recollections of the charming and courteous hospitality they received from Professor and Mrs. Dixon at their home in Temple Road, Dublin. After the death of Professor Joly in 1933 they had moved across the road to his house which had been bequeathed to Dixon together with its furniture and pictures. It was there, on a summer afternoon a few months before his death, that I last saw Henry Dixon. In spite of his age he had changed remarkably little. As he and Mrs. Dixon took me round their garden he pointed out to me how well the conifers and shrubs had grown since they had been planted there by the former owner—his old friend and colleague—John Joly.

N. G. Ball.

Mr. **Arthur J. Ivens,** F.L.S. died in hospital in London on Monday, 26 April 1954, at the age of 57.

After leaving school, he advanced his age, and at 17 joined the Royal Fusiliers, and saw service in France from 1915 until 1918.

After serving with the Army of Occupation he joined his father in 1919 working in his nursery at Harrietsham in Kent. He soon acquired a love of the uncommon in shrubs, and went to Messrs. Gauntlett's nurseries, Chiddingfold, where he interested himself especially in the propagating department, and became familiar with the considerable collection of Bamboos grown in that nursery.

In 1927 he joined the firm of Hillier & Sons, Winchester, and was foreman of their Chandler's Ford Nursery until 1937. At Chandler's Ford, working with the late Mr. Edwin Hillier, he was responsible for ericaceous and other plants which could not be grown on the lime saturated soil of the Winchester nurseries.

In 1937 he became Nursery Manager for Messrs. Clibrans at Altrincham, where he exercised his ability to manage horticultural production on a large scale. Whilst there he joined the L.D.V. at its inception, and held a commission in the Home Guard until the end of the War. When this Force was resuscitated he re-joined, and was holding a commissioned rank at the time of his death.

Leaving Altrincham in 1946 he returned to Messrs. Hillier & Sons' nurseries in Winchester, where he held the position of General Manager until the time of his death.

Being of retiring disposition he was, perhaps, not as widely known in the horticultural world as his qualifications merited. He possessed the rather unique quality of combining an accurate appreciation of botany with a keen sense of what was a good nurseryman's plant, and he succeeded in holding an even balance between business acumen, his love of horticulture and botany.

During his period at Chandler's Ford he made an extensive study of the Lapponicum series of Rhododendrons, and at the time of his death he was engaged in writing a monograph on the shrubby Potentillas, a group of plants about which he probably knew more than anyone.

He is survived by a widow and two daughters. H. G. Hillier.

The Rt. Hon. Sir Henry Duncan McLaren, C.B.E., LL.D., D.Sc., V.M.H., F.L.S., second Baron Aberconway, died on 23 May 1953, at the age of 74 at his home at Bodnant, North Wales. He was educated at Eton and Balliol College, Oxford. He was called to the Bar by Lincoln's Inn in 1905. He entered Parliament in 1906 as member for West Staffordshire, and was Parliamentary Private Secretary to the Chancellor of the Exchequer from 1908 to 1910. From 1910 to 1922 he represented the Bosworth Division of Leicestershire. He was Chairman of the great shipbuilding firm of John Brown & Co. which built the "Queen Mary" and "Queen Elizabeth", and Chairman of several other important industrial companies.

Lord Aberconway was always intensely interested in horticulture and the making of gardens. He liked all plants, but Rhododendrons, Camellias and Magnolias, both the species and the hybrids, were his special favourites. These genera grew well in his garden at Bodnant. He always tried to find the best form of each plant he grew, which made his garden of particular interest. He encouraged expeditions in search of new plants, especially those plants that would be hardy and an asset to British gardens. He was a keen hybridist of Rhododendrons and of the white Cypripedium and produced some fine hybrids which were awarded the highest honours by the R.H.S. Committees. It was a pleasure to him to distribute these fine plants that he raised, to fellow gardeners, to Botanical gardens and Research Institutions. He enjoyed nothing more than to fill his house at Bodnant at weekends with keen gardeners and scientists to see the gardens and discuss new plants and new ideas. All new ideas from helicopters to cytology were of great interest to him.

He was President of the Royal Horticultural Society from 1931 to 1953; during those years the Society grew from strength to strength under his leadership. The Society increased greatly in the number of its Fellows and the R.H.S. Garden at Wisley expanded in size and quality and beauty. Lord Aberconway became a Fellow of the Linnean Society in 1927 and served on the Council from 1933 to 1936, being a Vice-President in 1933.

His service to horticulture was great and was recognized by the award of the Victoria Medal of Honour by the Royal Horticultural Society, by the Massachusetts Horticultural Society awarding him the George Robert White Medal of Honour and in the same year, 1949, the University of Reading conferred upon him the degree of Doctor of Science. Lord Aberconway in 1949 presented his garden at Bodnant, with an endowment, to the National Trust. These beautiful gardens set in lovely country will be a living memorial to a great horticulturist.

F. C. Stern.

William T. Mathias, died very suddenly on 19 May 1954. He had been a member of the Linnean Society for nearly thirty years. Educated in Cardigan and later at the University College of Wales in Aberystwyth, he first held a post for one year as assistant lecturer in the University College of Wales in Bangor. Subsequently, he was appointed to the staff of the Botanical Department in the University of Liverpool—a post which he held to the day of his death.

Trained under Professor Lloyd Williams in Aberystwyth, it was natural that Dr. Mathias's botanical work should have lain in the field of phycology, but his interests were wide. His personal gifts of administrative and organizing ability inevitably led to his acceptance and faithful discharge of a multiplicity of responsibilities. His loss will be felt keenly in the University in which he spent the greater part of his working life and to which he gave generous and unremitting service. He was secretary to the Military Education Committee in the University, and played a part of some importance in connection with the Joint Matriculation Board. He was known and welcomed in schools all over the North-west as an excellent lecturer, and his organization as local secretary to Section K of the British Association will be fresh in the minds of those who attended the Meeting in Liverpool last September.

Dr. Mathias's greatest personal attribute was his quality of friendliness with staff and students in whom he took a deep and helpful interest. His friends were legion and drawn from all quarters, and his untimely death has brought sadness to a large number of people who knew him and liked him well.

M. K.

Arthur Anselm Pearson was born in London on 12 April 1874, and died at Hindhead on 13 March 1954, after an illness of some months' duration. He was educated for some years at a school in Belgium, but left at the age of 15 to join British Belting and Asbestos Ltd. Except for a year spent before the mast in a sailing ship the whole of Mr. Pearson's working life was devoted to this company, of which he became in turn company secretary, director, joint managing director and chairman. In his early years he played a great part in building up a large export trade, and for this purpose set himself to learn foreign languages, becoming a fluent speaker and writer in French, German, Spanish and Italian. His linguistic abilities were later to be of great value in his mycological studies and in facilitating contacts with the mycologists of other countries.

Mr. Pearson's interest in natural history began early in his married life, when he took up the study of botany as an alternative to golf, which he felt took him too much away from his family. He began with wild flowers, but was soon attracted to the large fungi. In 1911 he joined the British Mycological Society, and soon became one of its most useful and energetic members. He served the Society as Treasurer from 1919 until 1946, and for some years acted also as Foray Secretary. He was elected President in 1931 and again in 1952. Those who attended the autumn foray held in Normandy in September 1952 in conjunction with the French Société Mycologique will long remember the

ease and grace with which Mr. Pearson presided over the large mixed assembly, replying to municipal addresses of welcome and making his own Presidential Address (in French) a tribute to the work of French mycologists past and present. In 1946 he was made an Honorary Member of the Society, and in the same year became President of the Yorkshire Naturalists Union. He became a Fellow of the Linnean Society in 1917, and served on the Council from 1944 to 1948. He was also associated with various mycological societies abroad, being for many years a member of the Société Mycologique de France, and a member of the Mycological Society of America.

Mr. Pearson was an outstanding field mycologist. He regularly attended the forays organized by the British Mycological Society and also those of the Société Mycologique. He was an excellent collector, and up to a year before his last illness his energy was remarkable. He could cover far more ground than most collectors and yet miss nothing of interest. On his return to headquarters he would settle down with his microscope to study his finds, but always became surrounded by a host of younger workers seeking his aid. His help was always willingly given and many younger mycologists owe much to his guidance and stimulating influence. In the early years of his connection with the British Mycological Society he assisted the present writer greatly by making extensive collections of the then little known resupinate Basidiomycetes, and collaborated in various papers. Later he turned his attention to the Agaricales, and became known both in Britain and abroad as an authority on these fungi. There followed a series of papers in the Transactions of the British Mycological Society entitled " Agarics, New Records and Observations ", and in collaboration with Dr. R. W. G. Dennis a " Revised List of British Agarics and Boleti " (1948). Since the war various short papers were published in *The Naturalist*, including useful keys to the British species of *Boletus*, *Russula* and *Lactarius*. He was known to be preparing another key to the difficult genus *Cortinarius*, but apparently this did not reach completion before his illness. In 1931 he published a list of fungi collected in Spain (*Canavillesia* **4**, 1–4) and in 1950 a short paper on November Fungi in Portugal (*Port. Acta Biolog.* **3** (B) 193–200). In 1948 he went to South Africa at the invitation of the University of Cape Town in order to assist in the study there of the Agaricales of that region. The result was a list of more than 160 species, with many hitherto undescribed, published in the *Trans. Brit. Mycol. Soc.* **33**, 276–316, 1950.

After he settled at Hindhead Mr. Pearson became closely associated with the Haslemere Educational Museum, of which his old friend Mr. E. W. Swanton was then Curator. During the war he collaborated with Mr. Swanton in the collection and identification of fungi to be used in the search for antibiotics organized by the Mycological Laboratory of Oxford University.

As well as his connection with the Museum, of the management committee of which he was for some years chairman, and president in 1951, Mr. Pearson played a part in other local affairs. He was a member of the management committee of the Haslemere and District Hospital, a member of the governing body of Stoatley Rough School, and Vice-President of the Haslemere and District Youth Council.

He was fond of choral singing and a member of the Oriana Madrigal Society. He was also a supporter of the English Folk Dance and Song Society, and at times gave recitals of unaccompanied folk songs. His books on folk music and folk song were given to the Cecil Sharp Library.

His Library of Mycological books was bequeathed to the Linnean Society.

Mr. Pearson married Miss Ellen Cusack in September 1903, and is survived by her, three sons and two daughters.

E. M. WAKEFIELD.

George Simpson (1880–1952), was one of that chain of amateur botanists that has done so much to advance our knowledge of the flora of New Zealand. Simpson was always a man of the out-of-doors, and with his life-long friend J. Scott Thomson roamed our countryside to add indigenous plants to their gardens. Always eager to share their finds with others they naturally came into contact with botanists throughout the Dominion, and inevitably came under the influence of the late Dr. L. Cockayne. To their horticultural and ecological interests was added a desire to further taxonomic research. In all they published jointly 16 papers, and Simpson went on to publish three more. Of their joint papers may be mentioned "A wild *Hebe* Community in New Zealand" (*Genetica* **8**, 375–388) and "The Vegetation of South Island, New Zealand", with L. Cockayne (*Vegetationsbilder*, 1932). In all, descriptions of over 80 species were published.

Simpson became a life-member of the Otago Branch of the Royal Society of New Zealand, serving as a member of its Council from 1927–1940, 1943–1946, 1951–1952. He was President in 1931, and represented his Branch on the main Council 1939–1940.

He and his friend received the Loder Cup in 1935, awarded annually to those who have done most towards the "protection and cultivation of the incomparable flora of the Dominion". Simpson's most important sole paper was "A Revision of the Genus *Carmichaelia*", published by the Royal Society of New Zealand as the "Cockayne Memorial Paper, no. 1" in 1945. In preparation for this he had amassed in his garden a wonderful collection of plants taken from the field. Simpson was elected a Fellow of The Linnean Society of London in 1930, and of the Royal Society of New Zealand in 1949. Generously and assiduously he collected material for other workers, especially mosses and lichens. No worker, however junior, appealed to him in vain. His death removed from us a large-hearted colleague and a good companion. Nor will visiting botanists from other lands soon forget his whole-hearted help to them during their stay in New Zealand. H. H. Allan.

Wilfred Mark Webb, O.B.E., F.L.S., F.R.M.S., of The Hermitage, Hanwell, was born at Primrose Hill, London, on 28 May 1868. He was the son of the late William James Webb (Eastern Webb), artist, noted for his Academy pictures of birds. He was educated at St. John's Wood School and afterwards at University and King's Colleges, London.

His interest in Natural History began when at seven years old he was shown for the first time a long-tailed tit's nest by Mr. Robert Read, ornithologist. At the age of 13 he joined the Holmesdale Natural History Club. He was an original member of the Malacological Society (1893), and edited its *Journal* for three years. He was Lecturer on Biology to the Essex County Council (1893 to 1898) and to the Surrey County Council (1901 to 1908). He was Editor of *Country Home* from 1907 to 1912, and of *Knowledge* from 1910 to 1917.

As Secretary of the Corresponding Societies Committee of the British Association he served from 1914 to 1922. During both wars he served in the Postal Censorship as a handwriting expert and trained a large number of students as experts in the detection of forgery. It has been said that a student's certificate signed by him for studies carried out to his satisfaction was accepted throughout the world.

Perhaps Mr. Webb's greatest work was in connection with the Selborne Society (founded 1885), of which he became Hon. General Secretary in 1905, having previously served as Librarian. He became Editor of the *Selborne Magazine* in 1911 and kept these dual offices to the end of his life. Largely through his efforts, Perivale Wood and adjacent land, covering over 25 acres, was purchased on 2 March 1922 as a memorial to Gilbert White of Selborne,

to be known as the Brent Valley Bird Sanctuary. A Memorial Fund had been inaugurated in April 1920 to commemorate the bicentenary of the birth of Gilbert White (18 July 1920), and by March 1922 had reached a total of over £6000. The Bird Sanctuary Committee, of which Mr. Webb was Chairman and Mrs. Hilda E. Webb Hon. Secretary, were trustees for this fund and the property. To the maintenance of this Sanctuary Mr. Webb devoted himself, and as one of the first of such sanctuaries to be established near London it remains a memorial also to his endeavours.

Mr. Webb took a considerable part in organizing the first Nature Study Exhibition held in London in 1902, and collaborated with the writer in the Nature Study Exhibition held in the Gardens of the Royal Botanic Society, Regent's Park, in June 1909.

Mr. Webb's numerous publications included *The Eton Nature Study Book*, 1903; *Eton Nature Study and Observational Lessons* (with Matthew Davenport Hill), Parts 1 and 2, 1903–1904; *The British Woodlice* (with Charles Sillem), 1906; Gilbert White's *Nature Calendar* (for 1766), 1911; and *The Microscope and its Uses*, 1914.

A Gilbert White Exhibition arranged by the Selborne Society in the Theatre and Halls of the Civil Service Commission, Burlington Gardens, London, in February 1912, was organized by Mr. Webb. Almost the last of his activities was in support of an Exhibition illustrating the Life and Work of Gilbert White, held by the Bournemouth Natural Science Society to celebrate the Festival of Britain, September 1951, organized by the writer. Mr. Webb's name appears among the patrons of this Exhibition and a list of the very valuable and interesting exhibits contributed by him are included in the catalogue.

Mr. Webb will be remembered for his contributions to science and natural history, for his brilliant organizing powers and his active and forthright personality. He died in hospital on 7 January 1952, aged 83 years.

WINIFRED BOYD WATT.

Dr. **Roydon S. Wale** died in November 1952, after a lengthy battle with an incurable illness which he bore with the greatest fortitude. Until the last few months of his life he carried on his usual life ably and gallantly as pathologist to the city of Leicester. Like so many able medical men, Dr. Wale found relaxation from his arduous duties in the pursuit of botany and horticulture with a strong preference for the cultivation of alpine plants. Dr. Wale was for a number of years attached to the Victoria Hospital of East Grinstead and during those years he lived in the delightful Sussex village of West Hoathly. His love for Sussex was great and he knew this county better than most and preferred, like the writer of these notes, the Weald to the Downs. At West Hoathly he indulged in his love for rock-plants and constructed a very charming rock-garden in which many of the choicer plants flourished greatly under his understanding care. Although his love for these plants was wide he finally singled out the genus *Sempervivum* as his chief pre-occupation and chief study.

This genus, with a vast and confused nomenclature had been monographically revised by Dr. R. Lloyd Praeger early in the present century but much new material came to hand in subsequent years.

Collectors brought home unexpected species of Semperviva from Spain, a country curiously overlooked by Dr. Lloyd Praeger and wider ranging collectors found new species in the Balkan Peninsula and Asia Minor and in the Caucasus. Dr. Turrill of the Kew Herbarium found time to describe and name two or three of these, but it fell to Dr. Wale to study, describe, name and publish the rest, round about a dozen new species. The genus is not an easy one and is peculiarly difficult because of its succulent nature to study from herbarium material. For that reason Dr. Wale insisted on growing all these new introductions himself besides a full collection of the well-known

species and varieties, and a second complete and even larger collection of these plants was grown in the nursery of the writer and many were the hours we spent together with these interesting plants.

Not satisfied with studying Semperviva in cultivation only, Dr. Wale joined me in one of my Balkan tours where he could study a good many critical species which seemed to vary in appearance from mountain to mountain *in situ*. The results of his research were published either in the *Journal* of the Linnean Society or in the *Bulletin* of the Alpine Garden Society. Careful drawings and very clever photographs accompanied these valuable notes, and it had been my hope that eventually Dr. Wale would republish the result of his work together with the earlier work of Dr. Lloyd Praeger.

The second world war and Dr. Wale's removal to Leicester interrupted our pleasant companionship and mutual interest in the genus *Sempervivum*.

In the summer of 1952 Dr. Wale's illness took a turn for the worse and forced him to spend some weeks in hospital, but he rallied and during his convalescence I was able to spend a few days with him whilst he was recuperating. It was but natural that we should revert to our old love of the Semperviva, and we discussed again the possibility of publishing an up-to-date monograph of the genus to which we hoped to add the description of two or possibly three more species of Semperviva collected in Anatolia during 1953 by Dr. Peter Davis of Edinburgh. This was not to be; a relapse followed, and three weeks after our last meeting Dr. Wale died as bravely as he had lived.

Botany and Horticulture are the poorer for his passing.

We offer our sincere sympathy to his wife, his son, and his parents.

W. E. Th. I.

ADDITIONS AND DONATIONS TO THE LIBRARY

1952–53

Note.—Names of donors are given in square brackets. Separate copies of papers which are included in periodicals received by the Library are no longer catalogued.

Abercrombie, John. *See* **Mawe, Thomas.**

British Museum (Natural History).

ELLERMAN, J. R. & MORRISON-SCOTT, J.C.S. Checklist of Palaearctic and Indian Mammals 1758 to 1946. Pp. 810. 8vo. *London*, 1951.

Mosquitoes of the Ethiopian Region. 1. Larval Bionomics of Mosquitoes and Taxonomy of Culicine Larvae. By G. H. E. HOPKINS. Ed. 2. Pp. viii+356.

The Horse-flies (Diptera : Tabanidae) of the Ethiopian Region. Vol. I. Haematopota and Hippocentrum. By H. OLDROYD. 4to. *London*, 1951.

Diptera of Patagonia and South Chile. Part III. Mycetophilidae. By PAUL FREEMAN. Pp. viii+138+49 pls. 4to. *London*, 1951.

Handbook of R. H. Burne's Cetacean dissections. Pp. 70. 8vo. *London*, 1951.

A Checklist of the genera and species of Mallophaga. By G. H. E. HOPKINS & THERESA CLAY. Pp. 362. 8vo. *London*, 1951.

The John Murray Expedition 1933–34. Scientific Reports. Vol. IX, No. 4. The Epibionts and Parasites of the planktonic Copepoda of the Arabian Sea. By R. B. SEYMOUR SEWELL. 4to. *London*, 1951.

Fossil Mammals of Africa. No. 3. Associated jaws and limb bones of *Limnopithecus macinnesi*. By W. E. LE GROS CLARK and D. P. THOMAS. Pp. 28+6 pls. No. 4. Miocene Anthracotheriidae from East Africa. By D. G. MACINNES. Pp. 24+4 pls. 4to. *London*, 1951.

Expedition to South-West Arabia. 1937–8. Vol. I. Nos. 16–19. 4to. *London*, 1951.

A Catalogue of the American Hesperiidae in the British Museum. Pp. x+88. 8vo. *London*, 1951.

The Tertiary Cheilostomatous Polyzoa of New Zealand. By D. A. BROWN. Pp. xii+406. 8vo. *London*, 1951.

A Short Guide to the Exhibition Galleries of the Natural History Museum. 1951.

A list of British Mammals. By T. C. S. MORRISON-SCOTT. 8vo. *London*, 1952.

Economic Series No. 14. Clothes Moths and House Moths. Ed. 5. 8vo. *London*, 1951.

Chenevard, Paul. Catalogue des plantes vasculaires du Tessin. Pp. 553. 4to. *Genève*, 1910.

Clark, John. The Formicidae of Australia. Vol. I. Subfamily Myrmeciinae. Pp. 230. 8vo. *Melbourne*, 1951.

Cowan, J. Macqueen, *edited by.* The journeys and plant introductions of George Forrest, V.M.H. Pp. xii+252. 8vo. *London*, 1952. [EDITOR.]

Cuvier, G. Tableau élémentaire de l'histoire naturelle des animaux. Pp. xv+710. 8vo. *Paris*, 1798.

Damon, Robert. Geology of Weymouth, Portland and Coast of Dorsetshire. Pp. xii+250. 8vo. *Weymouth*, 1884. [DR. A. TINDELL HOPWOOD.]

Dawkins, W. Boyd. Early man in Britain and his place in the Tertiary Period. Pp. xxiv+537. 8vo. *London*, 1880.

Descole, H. R. Genera et Species Animalium Argentinorum. Vols. I and II. Pp. 390+27 pls.; 388+26 pls. 4to. *Bonarieae*, 1948–50.

Duncan, F. M. The transformation of Insects. Ed. 3. Pp. x+491. 8vo. *London*, (s.a.)

Elives, H. J. Primitive breeds of sheep and their crosses. Pp. 69. 8vo. *Edinburgh*, 1913.

Fehringer, Otto. Sumpf- und Wasservögel. Pp. 44+111. 8vo. *Heidelberg*, 1931.

——, ——. Die Singvögel Mitteleuropas. Pp. viii+107. 8vo. *Heidelberg*, 1922.

Fisher, James. The Fulmar. (New Naturalist Series.) Pp. xvi+496. 8vo. *London*, 1952.

Gay, F. J. *See* **Ratcliffe, F. N.**

Greaves, T. *See* **Ratcliffe, F. N.**

Haarer, A. E. Jute Substitute Fibres. Pp. xxii+186. 8vo. *Dorchester*, 1952. *Another copy in Spanish:* Fibras substitutas del yute. [Author.]

Hepburn, Ian. Flowers of the Coast. Pp. xiv+236. (New Naturalist Series.) 8vo. *London*, 1952.

Hey, Max H. An Index of Mineral Species and Varieties, arranged chemically. Pp. xx+609. 8vo. *London*, 1950.

Howe, T. H. Lessons on the Globes, on a plan entirely new, in which they are taken together in illustration of Terrestrial & Celestial phaenomena .... Pp. xii+436. 8vo. *London*, 1842.

Huxley, T. H. A manual of the anatomy of vertebrated animals. Pp. viii+510. 8vo. *London*, 1871.

Jaramillo-Arango, Jaime. Relación histórica del viage, qui hizo a los Reynos del Perú y Chile el botánico Dn. Hipólito Ruiz en el año 1777 hasta el de 1788, en cuya época regresó a Madrid. 2 vols. Pp. xliv+526; xx pls.+244. 8vo. *Madrid*, 1952. [Author.]

Leach, William. *See* **Stiles, Walter.**

Lindroth, Sten, *edited by.* Swedish Men of Science 1650–1950. Pp. 296. 8vo. *Stockholm*, 1952.

Lubbock, John. The scenery of Switzerland. Pp. xxxvi+473. 8vo. *London*, 1896.

Macleod, R. D. Key to the names of British Plants. Pp. x+94. 8vo. *London*, 1952. [Author.]

Manley, Gordon. Climate and the British Scene. Pp. xviii+314. (New Naturalist Series.) 8vo. *London*, 1952.

Mann, Patricia. Systematics of Flowering Plants. Pp. xii+307. 8vo. *London*, 1952. [Publishers.]

Mawe, Thomas, & Abercrombie, John. The Universal Gardener and Botanist.... 4to. *London*, 1778. [Dr. P. C. Esdaile.]

Mayer, Charles. Man: Mind or Matter? Pp. xx+168. Translated and with a Preface by Harold A. Larrabee. 8vo. *Boston*, 1951. [Author.]

Morrison-Scott, J. C. S. *See* **British Museum (Natural History).**

Nicholls, W. H. Orchids of Australia. Parts 1 and 2. Fol. *Melbourne*, 1951.

Owen, Ray D. *See* **Srb, Adrian M.**

Pascoe, Edwin H. A manual of the geology of India and Burma. Compiled from the observations of the Geological Survey of India and from unofficial sources by H. B. Medlicott, W. T. Blanford, V. Ball, and F. R. Mallet. Second edition by R. D. Oldham. Third Edition, revised and largely rewritten. 8vo. *Calcutta*, 1950.

Pinhey, E. C. G. The Dragonflies of Southern Africa. Pp. xvi+334. 8vo. *Pretoria*, 1951.

Praeger, R. Lloyd. Some Irish Naturalists. Pp. 208. 8vo. *Dundalk*, 1949.

Prestwich, Arthur A. Records of Parrots bred in captivity. Part VI (Grass Parrakeets). Pp. 289–378. 8vo. *London*, 1952. [Author.]

Pulle, A. Flora of Suriname (Netherlands Guyana.) 8vo. *Amsterdam*, 1928→.

Pulteney, Richard. A General View of the Writings of Linnaeus. 8vo. *London*, 1781. [Dr. Alan Fisk.]

Ratcliffe, F. N., Gay, F. J., & Greaves, T. Australian Termites. Pp. 124. 8vo. *Melbourne*, 1952.

Rehn, J. A. G. The Grasshoppers and Locusts (Acridoidea) of Australia. Vols. I and II. 8vo. *Melbourne*, 1952–3.

Richards, E. C. The Chatham Islands. Pp. x+177. 8vo. *Christchurch, N.Z.*, 1952.

Royal Entomological Society of London. Handbooks for the identification of British Insects. 8vo. *London*, 1949→.

Salisbury, Edward. Downs and Dunes. Pp. xiv+328. 8vo. *London*, 1952. [Author.]

Seebohm, Henry. Geographical distribution of British Birds. Pp. 112. 8vo. *London*, 1893.

Stebbing, T. R. R. The naturalist of Cumbrae. Pp. x+398. 8vo. *London*, 1891.

Srb, Adrian M., & Owen, Ray D. General Genetics. Pp. x+562. 8vo. *San Francisco*, 1952.

Steers, J. A. The Sea Coast. Pp. xii+276. (New Naturalist Series.) 8vo. *London*, 1953.

Stiles, Walter & Leach, William. Respiration in plants. Pp. viii+172. 8vo. *London*, 1952.

Swedish Men of Science. *See* **Lindroth, S.**

Symposia of the Society for Experimental Biology. No. IV. Physiological mechanisms in Animal Behaviour. Pp. viii+482. 8vo. *Cambridge*, 1950. No. VII. Evolution. Pp. xix+448. 8vo. *Cambridge*, 1953.

Taylor, William Randolph. Plants of Bikini and other Northern Marshall Islands. Pp. xvi+228+79 pls. 8vo. *Ann Arbor*, 1950.

Turner, E. L. & Gurney, Robert. A book about birds. Pp. 120. 8vo. *London*, 1925.

BENEFACTIONS

LIST *in accordance with Bye-Laws, Chap.* 17, *Sect.* 1, *of all Donations of the amount or value of Twenty pounds and upwards, received during the past five years.*

1949

The Royal Society : Grant-in-aid of publications, £750 ; Grant-in-aid of the Library, £250.
Mrs. C. M. Snow, F.L.S. : Donation to the Library Restoration Fund, £30.
Colonel F. C. Stern, O.B.E., M.C. : Donation to the Library Restoration Fund, £45.
Mr. A. E. Günther : 42 volumes of the late Dr. Albert Günther's work books, with a book-case.
Imperial Botanical Conference Trustees : Donation to the Library Restoration Fund, £57 4*s.* 11*d.*
Anonymous donor : £25 to the Library Restoration Fund.
The late Mr. R. J. Flintoff, F.L.S. : £1000 free of Legacy Duty.
Research Committee of the University of Liverpool : Donation towards the cost of Dr. C. Leighton Hare's paper on *Eriocaulon*, £25.
Miss I. M. Hayward : Bequest of £100 for general purposes.
Mr. D. J. Scourfield, I.S.O. : Bequest of £100 for general purposes.

1950

The Royal Society: Grant in-aid of publications, £750.
Miss E. F. Noel : Bequest of £100 for general purposes.
Mr. E. A. Robins : Long run of the Society's publications.
Mr. W. C. Barton : Long run of the Society's publications.
Mrs. E. W. Sexton : Donation towards the cost of the joint paper on *Jassa* in the *Journal, Zoology*, £50.

1951

The Royal Society : Grant-in-aid of publications, £750.
Mr. James Insch, F.L.S. : Bequest of Library of works on Tea.
Mr. John H. Robins : The collected correspondence of Richard Pulteney, F.R.S., F.L.S.

1952

The Royal Society : Grant-in-aid of publications, £1250.

1953

Auckland University College : Grant towards cost of Prof. V. J. Chapman's paper on New Zealand Algae in *Journal, Botany* (press), £500.
The Royal Society : Grant-in-aid of publications, £950.
Mr. J. D. Snowden : Gift towards cost of paper on *Sorghum* in *Journal, Botany* (press), £25.
Gift to Library Fund in Memory of Miss Maud Williams, F.L.S., £100.
Dr. Hugh Scott, F.R.S. : Cost of blocks for plates and £293 0*s.* 11*d.* towards cost of printing his Gughé Highlands' paper in *Proceedings*, **163**.

SYSTEMATICS ASSOCIATION.

ANNUAL REPORT XII (1952–53).

The eleventh Annual General Meeting was held on 29 May 1952 in the Board Room, British Museum (Natural History), Cromwell Road, London, S.W.7.

Reprints from the *Proceedings of the Leeds Philosophical Society*, VI, pt. 1, pp. 43–64 (1952) have been circulated to members. They contain a full report of the meeting on " Evolutionary Trends and Classification " held in Leeds, 28 April 1951. Reprints of a joint discussion between the Linnean Society of London and the Systematics Association on the " Taxonomic Treatment of Biological Races ", *Proc. Linn. Soc.*, **163,** pp. 40–57 (1952) have also been circulated to members.

A very successful meeting, arranged by the Northern Committee, was held in Sheffield during February, 1953. The subject was " The Status of the Genus and Subgenus ". Professor Clapham presided, and more than 30 members were present. It has been agreed that an informal report of the papers and discussion shall be circulated to members, the report to be entitled " Occasional Papers No. 1 ".

A joint meeting with the British Ecological Society was held in Edinburgh, 9 to 11 April, 1953 ; the meeting was well attended and enjoyed by all. The programme of this meeting has been circulated, and reports of the joint meeting will be published elsewhere. The morning meeting of 11 April was organized by the Systematics Association, and was devoted to a discussion on " Taxonomic Research—the problems and methods respectively suitable to the Universities and the Major Herbaria ", the nature of the discussion precluded a detailed report, but the following resolutions, passed at the meeting, were referred to the Council for consideration.

1. That the Council should contact the universities with a view to obtaining a list of unpublished papers and theses on subjects of interest to systematists. It was felt that a great deal of interesting and valuable matter was being disregarded, because of the present inaccessibility of such papers and theses.

2. That the card-index of taxonomic research kept by Mr. B. L. Burtt and the Botanical Secretary should be revised and published.

3. That the Association should be represented at the next International Botanical Congress (to be held in Paris, 1954), and that a discussion should be arranged on " The Progress of work on the European Flora ".

The Council has considered these resolutions and a report on action taken will be given later.

Education.

As a result of joint consultation between Dr. Walters, Mr. Dandy, Dr. Turrill and Mr. Burtt, the project of publishing a text-book of botanical taxonomy has been abandoned. It is felt that there are now a sufficient number of up-to-date works on this subject to meet requirements.

Similarly it was decided that there is no longer the need for an elementary text-book on botanical taxonomy, though the publication of a zoological treatise is still under consideration.

The manuscripts and papers of the Committee dealing with these matters have been forwarded to the Botanical Secretary, and the thanks of the Association have been sent to contributors.

SYSTEMATICS

General Account

Income	£	s.	d.
To Balance at Westminster Bank 30 April 1952	271	6	9
,, Annual subscriptions	32	10	0
, Clarendon Press, royalties on " The New Systematics "	19	10	7
	£323	7	4

Special Account

	£	s.	d.
To Balance in Post Office Savings Bank 30 April 1952	394	5	6
,, Life Memberships—2	0	0	0
,, Interest 1952	9	18	0
	£414	3	6

Balance

Liabilities	£	s.	d.
To Founder and Life Members—37	185	0	0
,, Annual subscriptions in advance—79	19	15	0
,, Sundry creditors :—			
Honorary Zoological Secretary	4	9	8
Honorary Botanical Secretary	0	2	9
Honorary Treasurer	0	14	2
,, Excess assets over liabilities	481	10	3
	£691	11	10

Audited and found correct—
VICTOR S. SUMMERHAYES
E. MILNE REDHEAD
22 May 1953.

ASSOCIATION

1952-53

EXPENDITURE	£	s.	d.
By Outstanding from previous year (on last balance sheet) :—			
Harding : Honorary Zoological Secretary's expenses	10	19	0
Kerrich : Honorary Treasurer's expenses	2	3	1
Harding : Honorary Zoological Secretary's expenses (September 1952)	6	19	6
,, Association's Headed Letter Paper	3	4	1
,, Couldrey & Co. : Duplicating Paper, etc.	4	12	6
,, Publications distributed to Members	10	15	6
,, Taxonomic Principles Committee	19	9	4
,, Balance at Westminster Bank 15 May 1953	265	4	4
	£323	7	4

1952-53

	£	s.	d.
By Balance in Post Office Savings Bank 15 May 1953	414	3	6
	£414	3	6

Sheet 1952-53

ASSETS	£	s.	d.
By Balance in Post Office Savings Bank	414	3	0
,, Balance at Westminster Bank	265	4	4
,, Subscribers—one year in arrear, 44 at 4s.	8	16	0
,, Subscribers—two years in arrear, 17 at 4s.	3	8	0
,, Stocks of Books	0	0	0
	£691	11	10

G. J. KERRICH,
Honorary Treasurer.
18 May 1953.

Taxonomic Principles.

Four of the memoranda previously considered only by the Taxonomic Principles Committee have been made available to all members of the Association. These are (1) The classification and coordination of Infra-specific categories, by P. C. Sylvester-Bradley; (2) The species concept and experimental taxonomy, by J. S. L. Gilmour; (3) Infra-specific categories, First Appendix; and (4) Infra-specific categories in Biosystematics, by J. S. L. Gilmour.

Future memoranda are to be circulated to members of the Committee only, but all members have been invited (a) to join the Committee, and (b) to contribute memoranda on subjects under consideration.

Considerable progress has been made with work on botanical terminology; it is proposed that some of the material collected should be made available to members, and a meeting arranged for discussion at an appropriate date.

Key Works.

The page- and book-proofs of the second edition of *Key Works* have been corrected and returned to the printers.

J. P. Harding
R. D. Meikle } *Hon. Secs.*

SYSTEMATICS ASSOCIATION.

ANNUAL REPORT XIII (1953–54).

The twelfth Annual General Meeting was held on 26 May 1953 in the Board Room of the British Museum (Natural History), Cromwell Road, London, S.W.7.

Botanical and Zoological Nomenclature.

Prior to the Annual General Meeting an informal discussion took place on changes in the Botanical and Zoological codes of nomenclature. The discussion was opened by Mr. P. C. Sylvester-Bradley (for the zoologists) and Mr. J. E. Dandy (for the botanists).

International Zoological Congress at Copenhagen.

Mr. Sylvester-Bradley was the Association's representative at the Colloquium on Zoological Nomenclature held at Copenhagen prior to the International Congress. The Colloquium put forward proposals, which were later adopted by the Congress, for the promotion of greater stability in zoological nomenclature. Our representative was subsequently elected Secretary-Designate to the International Commission on Zoological Nomenclature in succession to Mr. Francis Hemming.

International Botanical Congress at Paris.

In reply to a request from the Association for a vote at the Congress, a letter has been received from Dr. F. A. Stafleu stating that the executive committee of the International Botanical Congress has decided that only regular institutions possessing an herbarium and having active taxonomists on the staff will receive a vote at the Congress. No associations or societies will receive a vote.

Arrangements have been made through Prof. Humbert (Paris) for a free discussion, entitled "The Progress of Work on the European Flora" to be held at the Congress. Prof. D. H. Valentine has agreed to act as *rapporteur* at the meeting, and the Association will also be represented by Prof. T. G. Tutin, Dr. H. G. Baker, and Dr. J. G. Hawkes. Several distinguished European botanists have agreed to participate in the discussion. Prof. Valentine summarized the viewpoints of the British delegates at a meeting held in the rooms of the Linnean Society on Thursday, 8 April.

Taxonomic Principles.

The Taxonomic Principles Committee held a successful meeting in October 1953, when the subject of Deme Terminology was discussed, a joint paper by the Chairman and Prof. Heslop-Harrison forming the basis of the discussion. This paper is being published in *Genetica* and arrangements are being made for reprints to be circulated to members when available.

Manchester Meeting.

A successful paper-reading meeting was held in Manchester in December 1953, in which 7 speakers took part and 25 other members attended. The time of the meeting was rather near to Christmas otherwise it is thought that the attendance would have been higher. The meeting, however, proved very interesting and every item in the programme was followed by a lively discussion.

SYSTEMATICS

General Account

Income	£	s.	d.
To Balance at Westminster Bank 15 May 1953	265	4	4
,, Annual subscriptions	31	18	4
,, Clarendon Press : royalties and share of reproduction fee on " The New Systematics "	55	14	4
,, Internat. Trust Zool. Nomenclature : share of delegate's expenses (*v. contra*)	20	0	0
,, Transfer from Special Account *re* payment for " Bibliography of Key Works . . . "	200	0	0
,, Sales of " Bibliography of Key Works . . . "	102	4	11
	£675	1	11

Special Account

	£	s.	d.
To Balance in Post Office Savings Bank 15 May 1953	414	3	6
,, Life Memberships—5	25	0	0
,, Transfers from General Account *re* sales " Bibliography of Key Works . . ."	78	17	6
,, Sales : 3 Members' copies of above	1	2	6
,, Interest 1953	8	3	10
	£527	7	4

Balance

Liabilities	£	s.	d.
To Founder and Life Members—43	215	0	0
,, Annual subscriptions in advance—73	18	5	0
,, Sundry creditors :—			
Honorary Zoological Secretary (January–May 1954)	8	4	0
Honorary Botanical Secretary (May 1952–April 1954)		7	4
,, Excess assets over liabilities	539	16	11
	£781	13	3

Audited and found correct—
VICTOR S. SUMMERHAYES,
E. MILNE-REDHEAD.
17 May 1954.

ASSOCIATION

1953-54

Expenditure	£	s.	d.
By Honorary Zoological Secretary's expenses (January 1954)	14	15	6
,, Honorary Treasurer's expenses (May 1952–January 1954)	3	0	4
,, Couldrey & Co. : duplicating paper, envelopes, etc.	8	15	3
,, Linnean Society : reprints	27	7	6
,, Sylvester-Bradley : delegate to Internat. Zool. Conference	40	0	0
,, Baker : expenses of Manchester meeting		10	1
expenses attendance sub-committee	2	14	4
,, O.U.P. : " Bibliogr. of Key Works . . . "	340	11	10
,, Milner : bill-heads for Bibliography	1	10	8
,, Transfers to Special Account *re* sales of Bibliography	78	17	6
,, Balance at Westminster Bank 4 May 1954	156	18	11
	£675	1	11

1953-54

	£	s.	d.
By Transfer to General Account for payment for " Bibliography of Key Works . . . "	200	0	0
,, Balance in Post Office Savings Bank 4 May 1954	327	7	4
	£527	7	4

Sheet 1953–54

Assets	£	s.	d
By Balance in Post Office Savings Bank	327	7	4
,, Balance at Westminster Bank	156	18	11
,, Subscribers—one year in arrear, 54 @ 4*s*.	10	16	0
,, Subscribers—two years in arrear, 34 @ 4*s*.	6	16	0
,, " Bibliography of Key Works . . . " :—			
13 copies sold but not settled (@ 7*s*. 6*d*.)	4	17	6
733 copies unsold	274	17	6
	£781	13	3

There was an error of £5 in each of the last two balance-sheets, due to the omission from the Hon. Treasurer's (but not the Hon. Secretaries') list of one life member.

G. J. KERRICH,
Honorary Treasurer.
14 May 1954.

Key Works.

There is a steady demand for the second edition of *Key Works* and about 200 copies have been sold during the year.

Card Index of Botanical Research.

The Council has decided to publish annually a list of taxonomic research on European plants in progress in this country. The Botanical Secretary has undertaken the revision of the existing card-index of botanical research, and a questionnaire will be sent to botanical institutions throughout Britain asking for details. It is hoped that this index of systematic research may eventually lead to a more ambitious scheme on an international basis, and the matter will be discussed at the Paris Congress.

Royal Geographical Society.

The pamphlet on the symposium held in 1950 in conjunction with the Royal Geographical Society on the Cartographical Presentation of Biological Distributions has at last gone to press, and arrangements have been made for the purchase of sufficient reprints for a free distribution to all members.

Publications.

An *ad hoc* committee was set up to consider the production of a journal on Systematics. The idea of the Association running its own journal was an attractive one, but it was generally felt that there was already a sufficient number and variety of journals, and that the financial difficulties would be considerable. However, active consideration is being given to the issue of occasional publications.

J. P. Harding
R. D. Meikle } *Hon. Secs.*